

Observations on North Carolina Crayfishes (Decapoda: Cambaridae)

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ABSTRACT—*Cambarus* (*Tubericambarus*) *acanthura*, *Orconectes* (*Procericambarus*) *spinus*, and an apparently undescribed species of *Orconectes* (*O.* sp. B), are reported for the first time from North Carolina. Six additional specimens of *Orconectes* (*Crockerinus*) *virginiensis* are reported from the Chowan and Roanoke basins, and its range in North Carolina is clarified. *Orconectes* (*C.*) *erichsonianus*, for which a North Carolina locality has been published, is deleted from the State list. *Cambarus* (*Jugicambarus*) *asperimanus* is reported from the Watauga and New rivers in Watauga County, and localities are provided that expand its known range in the Piedmont Plateau. New locality data, distributional clarifications, or natural history notes are provided for *Cambarus* (*Depressicambarus*) *latimanus*, *C. (D.) reduncus*, *Cambarus* (*Jugicambarus*) *carolinus*, *C. (J.) dubius*, *C. (J.) nodosus*, *Cambarus* (*Puncticambarus*) *georgiae*, *C. (P.) parrishi*, *C. (P.) reburus*, *Procambarus* (*Ortmannicus*) *medialis*, *P. (O.) pearsei*, and *P. (O.) plumimanus*. A blue specimen of *C. latimanus* is reported from the Neuse River basin. The North Carolina crayfish fauna is correlated with the State's major river basins and physiographic provinces.

Thanks largely to the efforts of the late Horton H. Hobbs, Jr., U. S. National Museum of Natural History, Smithsonian Institution, with whom the modern era in crayfish studies essentially began, the composition of the crayfish fauna of North Carolina is relatively well known. As indicated in his most recent checklist of the American crayfishes (Hobbs 1989:89), the North Carolina fauna consists of 27 described native species, a putative subspecies of one of them, and one introduced species. Hobbs, sometimes with coworkers, described one of the four genera, six of the 11 native subgenera, and 11 of the 27 native species known to occur in the State at the time of his checklist.

In addition to the described species, at least four and probably five known but undescribed species from North Carolina await description. Hobbs and Peters (1977:8-9) mentioned *Cambarus* (*Cambarus*) sp. A, close to *Cambarus* (*Cambarus*) *bartonii* Fabricius; *Cambarus* (*Depressicambarus*) sp. B, close to *Cambarus* (*Depressicambarus*) *reduncus* Hobbs; and *Cambarus* (*Puncticambarus*) sp. C. The latter, *C. (P.)* sp. C, refers not to a single undescribed species but to an undiagnosed species complex that includes *Cambarus* (*Puncticambarus*) *acuminatus* Faxon, which is one of the 27 species listed for North Carolina. In fact, however, Hobbs (1969:135) said that *C. (P.) acuminatus* (*sensu stricto*) may be "confined to the Saluda drainage" of South Carolina, and later (Hobbs 1989:25) added, "Even in the Santee Cooper basin (of which the Saluda River is a tributary), . . . more than one rather distinct 'variant' is recognizable." We see no reason in our paper to depart from using *C. (P.)* sp. C for this complex until a diagnosis has been completed. Considering that the species in the complex range from the mountains to the coast in North Carolina, there probably are several awaiting description. Cooper and Cooper (1977a:198-199) and Cooper and Ashton (1985:9) commented on the undescribed *Orconectes* sp. A, and North Carolina localities for another apparently undescribed *Orconectes* (herein designated *O.* sp. B) are presented in our paper. One of us (JEC) is investigating a number of other new species, but further comment on them at this time would be premature. It is a certainty that other undescribed species await discovery in North Carolina.

About another widespread crayfish that occurs in parts of North Carolina, *Procambarus* (*Ortmannicus*) *acutus acutus* (Girard), Hobbs (1989:64) said, "With little doubt, the populations currently assigned to this subspecies constitute a species complex." The complex was under study by Hobbs and Hobbs (1990:608). Hobbs (1989:24) also said that *Cambarus* (*Lacunicambarus*) *diogenes* Girard, a broadly distributed crayfish whose range includes eastern North Carolina, "is a species complex and needs considerable attention." Jezerinac (1993:532) "concluded that the complex consists of two subgenera *Lacunicambarus* and *Tubericambarus*, new subgenus, and at least five additional species or subspecies." Another extremely variable crayfish that occurs in parts of North Carolina, *C. (C.) bartonii*, is also in dire need of revision. Hobbs (1969:146) referred to "the depauperate state of our knowledge of the relationships of those crayfishes which are currently being tentatively designated as *C. b. bartonii* . . ." Hobbs (1989:82, 89) included *Cambarus bartonii cavatus* Hay in his list of crayfishes occurring in North Carolina, but

North Carolina was not included in his statement of the range of this putative subspecies (Hobbs 1989:14). We have opted to omit it as a member of the North Carolina cambarid fauna until specific evidence appears to support its inclusion.

Four described species are North Carolina endemics: *Cambarus (Depressicambarus) catagius* Hobbs and Perkins, of the upper Cape Fear River basin; *Cambarus (Puncticambarus) reburrus* Prins, of the French Broad and Savannah basins; *Procambarus (Ortmannicus) medialis* Hobbs, of the Neuse and Tar-Pamlico basins; and *Procambarus (Ortmannicus) plumimanus* Hobbs and Walton, of the Northeast Cape Fear and New (White Oak) basins, which, as we explain later, may be expanding its range into the lower Neuse basin. The undescribed *Orconectes* sp. A is another North Carolina endemic, found only in the Neuse and Tar-Pamlico basins.

This article adds two described and one undescribed native species to the State list, provides additional distributional and natural history information for them and 13 other species, deletes a species for which a North Carolina locality has been published, correlates the State's crayfish fauna with its major hydrologic units, and summarizes the distribution of this fauna in the State's three major physiographic provinces.

Abbreviations used are as follows. SR = secondary road (formerly CR for county road); NC = North Carolina state highway; US = United States highway (an A after the number means alternate highway); I = interstate highway; FRS = United States Forest Service Road; cntn = center of town or city; NCSM C- = crustacean collections, North Carolina State Museum of Natural Sciences, Raleigh; USNM = collections, U. S. National Museum of Natural History, Smithsonian Institution, Washington, D. C. Collector's names are given in first usage, initials thereafter.

Cambarus (Depressicambarus) latimanus (LeConte)

Hobbs (1981:120), reporting observations made in a thesis by J. L. Boyce (1969), stated that in Yellow River, Georgia, *C. latimanus* "becomes relatively inactive during December, January, and February," Hobbs (1981:119) also provided monthly capture data for a large number of specimens that suggested the same thing: 77 collected in November, five in December, 21 in January, and none in February, as opposed to 164 in March, 1,079 in April, and relatively high numbers in most other months. These kinds of collecting data, however, can be more a reflection of seasonal activities of the collectors than of the collected. If we can equate "activity" with "catchability,"

and in the case of animals taken in traps we feel justified in so doing, *C. latimanus* is not inactive during winter months in eastern North Carolina. Intensive sampling was conducted in the Neuse River basin from late December 1978 through May 1979, and in the Tar-Pamlico basin from January through April 1980, most of it part of a study of the distribution and ecology of the salamander, *Necturus lewisi* (Brimley) (Braswell and Ashton 1985). This effort yielded considerable winter and spring capture ("activity") data for 409 adult and 279 juvenile *C. latimanus*, the majority of them caught in traps (Table 1).

Bouchard (1978:37) remarked on a dearth of ovigerous females in collections of this species, saying, "Of the numerous collections of *C. latimanus* that have been made, only three specimens are females with eggs (or young)." One of these females was collected in a tributary of the Neuse River in Wake County, North Carolina, on 16 April 1977, the other two were collected in Alabama on 22 April 1973. Hobbs (1981:119), who examined 2,424 specimens of this species from approximately 400 localities, remarked, "I have no records of ovigerous females or of those carrying young anywhere within its range This paucity of such females in collections almost certainly reflects inadequate sampling of burrows in the banks of streams." Most of the smallest juveniles collected in the Neuse and Tar-Pamlico surveys were taken in late April and May. This, combined with the few available dates of capture of ovigerous females, Bouchard's (1978:47) report of a copulating pair found on 2 November 1974 in Alabama, and the fact that nearly 50 percent of the males in the January sample reported in Table 1 were form I, leads us to suggest that in eastern North Carolina (1) mating and egg production occur in winter and perhaps late fall, (2) incubation occurs during winter and early spring,

Table 1. Summary of winter and spring captures of *C. latimanus* in the Neuse and Tar-Pamlico river basins, 1978-1980.

Month	♂ I	♂ II	♀	juv	N
Jan	46	48	81	21	196
Feb	15	20	39	46	120
Mar	14	40	50	22	126
Apr	9	19	23	168	219
May	<u>1</u>	<u>2</u>	<u>2</u>	<u>22</u>	<u>27</u>
Totals	85	129	195	279	688

and (3) the young are produced later in the spring (a time of high water, expanded habitat, and increased availability of food). This supports Thorp's (1978:278) statement that in the lower Savannah River basin of South Carolina this species "enters the reproductive period as temperatures are dropping in fall and winter."

On 17 February 1982, a blue specimen of *C. latimanus* was found by a worker clearing a muddy ditch at the south end of the Wayne Community College campus in Goldsboro, Wayne County (Neuse River basin). It was taken to Gary W. Woodyard of the college biology faculty, who generously donated it to the N. C. State Museum. The animal, a form II male (NCSM C-775), was generally cobalt blue, with the pigment obviously in the exoskeleton since the underlying chromatophore pattern of blotches and abdominal stripes was clearly visible. The right cheliped was missing, but the left cheliped and all pereopods were whitish on the ventral surfaces, with a pale bluish tint at the base of the coxa of each limb. The lateral margin of the palm and propodus was very light blue, but the entire dactyl was darker except at the ventral tip. The gonopods (first pleopods), eyestalks, antennae, antennules, and antennal scales were pale blue. There was a small white area on the anterolateral carapace just below the suborbital angle and along part of the margin of the carapace. The small tubercles and punctations of the carapace were points of white, as were the small cervical spines. Most of the ventral abdomen was clear, but the transverse ridges between segments were blue.

This is the first blue individual reported for this species, and the first blue crayfish reported for any non-blue species in North Carolina. One North Carolina crayfish, *Cambarus (Jugicambarus) dubius* Faxon, is known to have a cobalt blue color morph. In the area where the blue *C. latimanus* was found, the species normally is light tan or greenish, with dark brown or green carapace markings and abdominal stripes. Hundreds of normal-colored specimens of this species have been collected in the Neuse River and its tributaries, including a number from Wayne County.

Fitzpatrick (1987) summarized most of the known records for the "blue color phase" in six crayfish genera, and discussed environmental (diet and illumination) versus genetic causes of such color variations. Penn (1951) reported a blue color variant of *Procambarus (Scapulicambarus) clarkii* (Girard), a normally red species, in Louisiana. Penn later (1959:10) said, "In recent years anomalous bright blue specimens have appeared in several parts of the state" (That someone may be culturing this obviously genetic variant is

indicated by the fact that in April 1984 JEC examined several bright blue specimens of this species, said to be from "Thailand," that were for sale as exotic novelties in a Raleigh tropical fish shop. A form I male was purchased and is in the NCSM collections, C-1295.)

Smiley and Miller (1971:221) estimated the frequency of blue variants in normally non-blue *P. a. acutus* as 1 in 50,000. Black (1975) experimentally demonstrated that blue color in this species is a mutation, in which the gene controlling the chemical composition of a carotenoid pigment in the exoskeleton behaves as a single recessive allele, with complete penetrance of the dominant normal allele. He estimated the ratio of blue to normal crayfish in the pond of origin of his parental stocks at 1:5,600. Anthony D'Agostino has bred cobalt blue *Homarus americanus*, and the F₁ offspring inherit this coloration as a homozygous recessive trait (Porterfield 1982:38), which is what Black found in *P. a. acutus*.

With a nod to William of Occam, we find it considerably more parsimonious to conclude that the Wayne County *C. latimanus* was a genetically blue individual than that its abnormal color was produced by diet or environmental conditions.

In North Carolina, *C. latimanus* is a common, widespread inhabitant of the eastern Piedmont Plateau and much of the Coastal Plain. It is possible, though, that it also occurs in the Hiwassee River basin of the Blue Ridge, as we discuss later.

Cambarus (Depressicambarus) reduncus Hobbs

Bouchard (1978:40) gave the range of this species as "in the Piedmont province from the Cape Fear River drainage in North Carolina southward to the Santee River basin . . .," and in the latest American checklist Hobbs (1989:16) gave it as "Piedmont Province from Orange County, North Carolina to Richland County, South Carolina." Concerning the northern terminus of its range, these statements almost certainly were based on specimens from the upper Cape Fear basin in and around Chapel Hill, Orange County, earlier reported by Hobbs (1956:66-67) and Hobbs and Peters (1977:50). Although Cooper and Ashton (1985:9) had reported *C. reduncus* from the Neuse and Tar-Pamlico basins, north of the Cape Fear, they gave no particulars. The following localities extend the known range of this species north into the Piedmont headwaters of these two rivers, very close to the Roanoke River basin.

NEUSE RIVER BASIN. *Durham Co.*—(1) Lick Crk at SR 1905, 10 air mi (16 air km) E Durham; 1 ♂ I (NCSM C-520), 27 Jan 1979, A. P. Capparella. *Granville Co.*—(2) burrow in roadside ditch along

SR 1721, 3.5 air mi (5.6 air km) SE cntr Creedmoor, near Wake Co line; 1 ♂ I (NCSM C-860), 23 Apr 1978, R. E. Ashton, Jr.; (3) swamp at E edge Lake Rogers (on Ledge Crk), 1 air mi (1.6 air km) NW Creedmoor; 1 j ♂, 9 Mar 1991, D. G. Cooper, JEC. *Wake Co.*—(4) burrow in lawn, Morrisville; 1 ♀ (NCSM C-907), 27 Mar 1978, J. Clayton; (5) alive on SR 1300 (Hemlock Bluffs Rd) N of bridge; 1 ♂ I (NCSM C-909), night 3 Nov 1977, R. W. Laney, D. F. Lockwood; (6) alive on road, 0.5 mi (0.8 km) W jct SR 1379 & Kildaire Rd; 1 ♂ I (NCSM C-910), night 3 Nov 1977, RWL, DFL. **TAR-PAMLICO RIVER BASIN.** *Granville Co.*—(7) alive on road, jct SR 1304 & 1307, 1.8 air mi (2.9 air km) W Hebron; 1 ♂ II (NCSM C-1262), night 23 Apr 1983, J. P. Kumyhr, D. Smith. *Person Co.*—(8) Tar R at SR 1565, 1.7 air mi (2.7 air km) WSW Dennys Store; 1 ♂ I, 1 ♀ (NCSM C-665), 20 Feb 1980, trap, E. Rawls. *Vance Co.*—(9) Tabbs Crk at SR 1101, 2.3 air mi (3.7 air km) W Kittrell; 1 ♂ I, 1 ♀ (NCSM C-655), 24 Jan 1980, trap, ER.

Hobbs and Peters (1977:18) reported *C. reduncus* from "Montgomery County: (2) Hamer Creek, 3 mi (4.8 km) N Richmond Co line on St Rte 73," assigning the locality to the "CATAWBA BASIN." This locality, though, like nearly all of Montgomery County, is in the Yadkin-Pee Dee basin. The following collections of *C. reduncus*, however, are known from the Catawba basin in North Carolina:

Gaston Co.—(1) small stream (trib South Crowders Crk) near office Crowders Mountain State Park, off SR 1125, 0.6 rd mi (0.9 rd km) SW jct SR 1106, 5.2 air mi (8.3 air km) S Bessemer City; 1 ♂ II, 1 j ♂, 3 ♀, 4 j ♀ (NCSM C-2300), 22 Apr 1985, ALB. *Mecklenburg Co.*—(2) plowed field along dirt rd at E end SR 3629 (Sixmile Crk dr), ca. 6.3 air mi (10.1 air km) SE cntr Pineville; 1 ♂ II, 4 j ♂, 1 ♀, 2 j ♀ (NCSM C-1043), 19 Apr 1980, from burrows with chimneys, N. L. Elliott; (3) ditch along SR 3629 (Sixmile Crk dr), ca. 5.6 air mi (8.9 air km) SE cntr Pineville; 9 j ♂, 1 ♀, 11 j ♀ (NCSM C-1045), 19 Apr 1980, NLE. *Union Co.*—(4) along SR 1624, 0.5 rd mi (0.8 rd km) NW jct NC 200, 2.0 air mi (3.2 air km) NNE Monroe; 1 ♂ I (NCSM C-311), 15 Jul 1978, J. W. Braswell, Jr., ALB; (5) East Fk Twelve Mile Crk at SR 1329, ca. 2.1 air mi (3.4 air km) SSW Wesley Chapel; 1 j ♂, 3 j ♀ (NCSM C-1031), 18 Apr 1980, in roadside ditch fed by woodland pool; 1 j ♂, 3 j ♀ (NCSM C-1047), 18 Apr 1980, in shallow, temporary floodplain pools; 1 ♂ II, 1 j ♀ (NCSM C-1027), 26 Apr 1980, dug from burrows with chimneys in old-field, NLE; (6) small branch Little Twelve Mile Crk at SR 1329, ca. 2.9 air mi (4.6 air km) SSW Wesley Chapel; 4 j ♂, 7 j ♀ (NCSM C-1037), 18 Apr 1980, NLE; (7) woodland pool off Little Twelve Mile Crk at SR 1328,

ca. 3.1 air mi (5.0 air km) SW Wesley Chapel; 3 j ♂, 1 j ♀ (NCSM C-1040), 18 Apr 1980, NLE; (8) damp ditch at East Fk Twelve Mile Crk at SR 1336, ca. 1.6 air mi (2.6 air km) SW Wesley Chapel; 1 j ♂, 1 j ♀ (NCSM C-1038), 20 Apr 1980, from burrows, NLE.

Cambarus (Jugicambarus) asperimanus Faxon

This crayfish occurs in the Watauga River basin in Tennessee (Hobbs 1989:20), but no localities for the species have been reported from this system in North Carolina. Additionally, no one unequivocally has reported its occurrence anywhere in the New River basin. With respect to the latter, in a discussion of "*Cambarus (Cambarus) bartoni asperimanus*," Ortmann (1931:138) stated, "I have a male (I) and two females from Blowing Rock (in the headwaters of New River, some distance northeast of Asheville), in which the inner margin of the palm has the tubercles somewhat more strongly developed than is usual in *bartoni*. This indicates a transition toward *asperimanus*. However, I prefer to leave these with *bartoni*; the character being much less distinct here than in the specimens from Asheville and Canton" (Buncombe and Haywood counties, respectively, French Broad River basin). There is one other published locality for *C. asperimanus* that could be in the New River basin, but it was not reported as such. Hobbs and Peters (1977:57) recorded the species from "Watauga County: (8) creek at Deep Gap," but placed this locality in the Pee Dee (Yadkin) basin. This citation does not indicate whether "creek at Deep Gap" refers to the community of Deep Gap, or the mountain gap of the same name. The community is in eastern Watauga County on Deep Gap Creek, a tributary that joins South Fork New River in Ashe County. The mountain gap lies southeast of the Blue Ridge, in the drainage of Stony Fork Creek, a headwater tributary that enters the Yadkin River in western Wilkes County.

On 25 July 1984, we collected *C. asperimanus* in both the Watauga and New River basins at the following localities. WATAUGA RIVER BASIN. *Watauga Co.*—(1) small stream entering N bank Watauga R at NC 105 bridge, jct SR 1112, ca. 2.4 air mi (3.8 air km) SE Valle Crucis; 2 ♀ (NCSM C-1811), from under separate rocks at mouth of stream. NEW RIVER BASIN. *Watauga Co.*—(2) small, shallow creek (South Fk New River dr) in hardwood ravine and meadow on E side Howard Knob, off Hidden Valley Circle, 0.3 rd mi (0.5 rd km) from jct Chestnut Drive in north Boone; 1 ♂ I, 5 j ♂, 1 ♀, 1 j ♀ (NCSM C-1814), 1 ♀ with attached young (NCSM C-1815), 3 ♀, 1 j ♀ (NCSM C-1816), with R. W. VanDevender.

At the Watauga River locality, the only other crayfish collected was *Cambarus (Puncticambarus) robustus* Girard, all specimens of which were taken from the river itself. At the New River locality, the orangish-tan *C. asperimanus* were "associated" with cobalt blue *C. dubius*. The two species were dug from burrows within a few meters of each other, but their habitats differed. The *C. asperimanus* that came from burrows were in simple, shallow burrows at or just above water level along the banks of the creek, while the *C. dubius* were dug from more complex burrows in a mucky seepage area near the same creek. Some *C. asperimanus* were found under rocks in the creek, but no *C. dubius* were in this habitat, and no *C. asperimanus* were dug from the seep.

The limits of the range of *C. asperimanus* east of the Blue Ridge escarpment in North Carolina are not yet clear, but we made a number of collections of the species at the base of the eastern foothills and in the Piedmont as far east as western Catawba County. Hobbs and Peters (1977:57) first recorded the species in this area, from a locality in the upper Catawba basin in northwestern Burke County. Our collections at the following new localities extend the range of *C. asperimanus* farther east in the Catawba basin, and south and east into the Broad River basin.

CATAWBA RIVER BASIN. *Burke Co.*—(1) Jacob Fk nr office South Mountain State Park, 3.4 air mi (5.4 air km) SW Pleasant Grove; 1 ♂ I, 3 ♂ II, 1 j ♂, 4 ♀ (NCSM C-2281), 23 Apr 1985; (2) Laurel Crk along NC 18, 2.0 rd mi (3.2 rd km) ESE jct SR 1929, 3.2 air mi (5.1 air km) N Pleasant Grove; 2 ♂ I, 5 j ♂, 6 j ♀ (NCSM C-2286), 1 ovig ♀ (NCSM C-2309), 26 Apr 1985. *Catawba Co.*—(3) small stream (trib Henry Fk) along I 40 at milepost 120 near Burke Co line, ca. 4.0 air mi (6.4 air km) SW cntr Hickory; 1 ♂ II, 3 j ♂, 1 ♀, 1 j ♀ (NCSM C-1257), 12 Apr 1983. *McDowell Co.*—(4) trib Swannanoa Crk along SR 1400, 1.3 rd mi (2.1 rd km) W jct E end SR 1407, 2.1 air mi (3.4 air km) WNW cntr Old Fort; 2 ♂ I, 2 ♂ II, 1 j ♂ (NCSM C-807), 20 Aug 1977; (5) trib Catawba R along US 70, 3.1 mi (5.0 km) E Buncombe Co line, 2.3 air mi (3.7 air km) WSW cntr Old Fort; 2 ♀ (NCSM C-949), 24 Nov 1978, with D. L. Stephan; (6) small cascading stream (trib Swannanoa Crk) along SR 1407, ca. 0.4 rd mi (0.6 rd km) NE Buncombe Co line, ca. 5.0 air mi (8.0 air km) W cntr Old Fort; 1 j ♂, 3 ♀, 1 j ♀ (NCSM C-1251), 12 Apr 1983; (7) Long Br (trib Mill Crk) along SR 1407, 0.4 rd mi (0.6 rd km) S railroad crossing, 1.5 air mi (2.4 air km) SE Graphite & 3.2 air mi (5.1 air km) WNW cntr Old Fort; 1 ♂ II, 1 j ♀ (NCSM C-1258), 12 Apr 1983; (8) Buck Crk at NC 80 bridge, 0.4 rd mi

(0.6 rd km) N jct SR 1437, ca. 0.2 air mi (0.3 air km) E Sunny Vale; 1 ♀ (NCSM C-2200), 26 Sep 1984. BROAD RIVER BASIN. *Cleveland Co.*—(9) small stream (Buffalo Crk dr) in hardwoods, 0.8 rd mi (1.3 rd km) S Lincoln Co line, 2.3 air mi (3.7 air km) NNE Belwood; 1 ♂ II, 3 j ♂, 3 j ♀ (NCSM C-2283), 22 Apr 1985. *McDowell Co.*—(10) intermittent creek (trib Cane Crk) in hardwood ravine along NC 226, 0.1 rd mi (0.2 rd km) WNW Rutherford Co line, 3.4 air mi (5.4 air km) SE Dysartville; 4 ♂ II (NCSM C-987), 25 Jun 1977, 2 ♂ I, 5 ♂ II, 11 j ♂, 9 ♀, 14 j ♀ (NCSM C-1821), 1 ♀ with attached young (NCSM C-1823), 1 ♂ II, 1 j ♂, 2 ♀ (NCSM C-1824), 26 Jul 1984. *Rutherford Co.*—(11) trib Broad R at NC 9, ca. 0.3 air mi (0.5 air km) S town Lake Lure; 1 ♂ II (NCSM C-64), 6 Aug 1976; (12) small stream in steep ravine at NC 9, 0.8 rd mi (1.3 rd km) W cntr town Chimney Rock; 1 ♀ (NCSM C-959), 3 ♂ II, 1 ♀ (NCSM C-960), 5 Jun 1977, with E. Messersmith. *Polk Co.*—(13) unnamed trib Green R near Raccoon Mountain; 1 ♂ I (NCSM C-2012), summer 1974, G. G. Shaw.

We conclude, based on the apparently broad temporal distribution of ovigerous females and those with young, that *C. asperimanus* either has an extended breeding season or has a long development time for the ova and young. Hobbs (1981:190) reported an ovigerous female taken in Rabun County, Georgia, in April 1977, and said that "elsewhere" such females have been taken in April, June, and December. The latter statement may have been based on Bouchard (1972:47), who reported ovigerous females (presumably in Tennessee) in "April to June and December." As indicated above, we collected a female with attached young in Watauga County on 25 July 1984, and another a day later in McDowell County. David G. Cooper collected a female with three attached young in Jackson County on 10 August 1993. In addition, we found a number of individual females closely associated with groups of tiny young in Macon County on 19 September 1984, and on this same date we found free-living young of the same size.

The Jackson County female collected by DGC on 10 August 1993 is the largest *C. asperimanus* we have seen, with a total carapace length (TCL) of 42.0 mm and a postorbital carapace length (PCL) of 37.0 mm. Another very large specimen, a form I male measuring 38.0 mm TCL (32.5 mm PCL), was collected by DGC at the same site on the same date. We collected a form I male in Macon County that measured 36.0 mm TCL (31.5 mm PCL). The only other size data we know of for this species are those of Hobbs (1981:190). His largest

Georgia specimen, an ovigerous female, measured 30.5 mm TCL (26.7 mm PCL), and his largest form I male was 27.6 mm TCL (24.1 mm PCL).

Cambarus (Jugicambarus) carolinus (Erichson)

Although Hobbs and Bouchard (1973:42), Bouchard (1976:594), and Hobbs (1989:21) included southwestern North Carolina, south and west of the French Broad River, within the range of this species, no one has yet reported precise locality or natural history data for this primary burrower in North Carolina. Faxon (1890:624) reported a form I male of his *Cambarus dubius*, collected by James Mooney from " 'Among the Cherokees,' Indian Territory," and said, "According to the label accompanying the specimen it is called *Tsisgágili* (red crayfish) by the Cherokee Indians." The same author later (Faxon 1914:396) included this specimen (USNM 14314) under *C. carolinus*, said "I am advised by Mr. Mooney that it was in reality obtained in Swain Co. or in Jackson Co., N. C.," and added (Faxon 1914:397) that "The living color . . . was red . . ." Ortmann (1931:147) reported Faxon's specimen under "*Cambarus (Cambarus) carolinus*," and inexplicably indicated that it was from "Cherokee Co.; North Carolina." He added, "I have seen, at Murphy, Cherokee Co., crawfish-chimneys, and tried unsuccessfully to dig out specimens The owner of the place told me, that these were *red* crawfish, and thus probably this species." Ortmann (1931:147) also recorded the species from "Swampy ground near springs, Marion, McDowell Co. . . . Swamp, Ashville [sic], Buncombe Co., . . .," and "Blowing Rock, Watauga Co., . . ." These three localities are outside the range of *C. carolinus* as currently understood, but the last two are within the known range of *C. dubius (sensu lato)*. The McDowell County locality is in the western Piedmont Plateau, in the headwaters of the Catawba River basin, beyond the known ranges of both *C. carolinus* and *C. dubius*. Brimley (1938) recorded *C. carolinus* at "Judson," and Hobbs and Bouchard (1973:21) called for confirmation of this record. This would have been a reasonable place to find *C. carolinus*, since Judson was a community on the Little Tennessee River in southwestern Swain County, but it is now beneath the waters of Fontana Lake (Powell 1968:259). The reference by Harris (1903:142) to "*C. carolinus*" in the Tar-Pamlico River basin was clearly in error.

We made the following collections of specimens referred to this species at the indicated localities, all within the basin of the Little Tennessee River: *Clay Co.*—(1) boggy spring seep in Riley Cove, off unnumbered dirt road reached from US 64, 3.3 rd mi (5.3 rd

km) S jct SR 1359 & 1.2 rd mi (1.9 rd km) W jct FSR 71 (old US 64), Nantahala National Forest; 1 ♂ II (NCSM C-948), 16 Aug 1977, 1 ♂ I, 1 ♂ II, 5 j ♂, 4 ♀, 3 j ♀ (NCSM C-2165), 1 ♂ II, 1 ♀ (NCSM C-2166), 21 Sep 1984. *Graham Co.*—(2) dug from muck in Talulah (Tulula) Bog, along US 129, 1.4 rd mi (2.2 rd km) E jct SR 1201, 6.7 air mi (10.7 air km) SE Robbinsville; 1 j ♂, 2 ♀, 1 j ♀ (NCSM C-2290), 25 Apr 1985; (3) small boggy area near Cheoah R along SR 1147, 0.1 rd mi (0.2 rd km) S jct US 129; 1 ovig ♀, 1 j ♀ (NCSM C-2310), 26 Apr 1985. *Macon Co.*—(4) boggy area around floodplain pond by Nantahala R, off US 19, ca. 0.5 rd mi (0.8 rd km) NE Graham Co line & 5.2 air mi (8.3 air km) NW Kyle; 1 ♂ II, 1 j ♂, 1 ♀, 1 j ♀, remains of decomposed ♂ I, pair of loose chelipeds (NCSM C-2292), 24 Apr 1985, with J. Bauman; (5) dug from sphagnum bog and margin murky stream along Little Choga Crk on SR 1402, 3.3 rd mi (5.3 rd km) SE jct SR 1401, 3.2 air mi (5.1 air km) WSW Aquone; 1 ♂ II, 1 ♀ (NCSM C-2287), 25 Apr 1975, with JB; (6) under rocks in wet roadside ditch along SR 1401, 2.9 rd mi (4.6 rd km) NE jct SR 1402, 2.3 air mi (3.7 air km) WNW Aquone; 2 j ♂ (NCSM C-2289), 25 Apr 1985, with JB.

All the specimens were brick red in color, and all except those from locality (6) were dug from burrows, usually constructed among soil and roots in boggy areas. The bog at locality (1) was about 8 m from a small, rocky stream, tributary to Buck Creek (Nantahala River). Only one other crayfish, a juvenile male *C. b. bartonii*, was dug from this bog. In the nearby stream, under rocks and in substrate under rocks, we found other *C. b. bartonii*, and a female of an unidentified *Cambarus*. The stream was about 1- to 1.5-m wide, 7- to 8-cm deep, and had a low gradient and low velocity current. At locality (4), an unidentified *Cambarus* was found under a rock in wet sand near the bog, and at locality (5) *C. b. bartonii* was found in the stream but not in the boggy area.

Cambarus (Jugicambarus) dubius Faxon

There are a number of published localities for *C. dubius* in North Carolina, including recent ones in Hobbs and Peters (1977:24, 50; 1989:324). The range of the species in North Carolina, however, is poorly known, both because it is a primary burrower and difficult to find and collect, and because of taxonomic uncertainties. In general, the species occurs in "northwestern North Carolina" (Hobbs 1989: 22), "north and west of the French Broad River basin" (Bouchard 1976:594). Little has been published about its natural history in North Carolina.

The following collections of *C. dubius* are of distributional and natural history interest. NEW RIVER BASIN. *Watauga Co.*—(1) seepage area near small, shallow creek (South Fk New R dr) in hardwood ravine and meadow on E side Howard Knob, off Hidden Valley Circle, 0.3 rd mi (0.5 rd km) from jct Chestnut Drive, in north Boone; 3 ♂ II, 8 j ♂, 2 ♀, 8 j ♀ (NCSM C-1812), 2 ♀ with attached young (NCSM C-1813), 2 j ♀ (NCSM C-1817), 1 ♂ I, 5 ♂ II, 3 j ♂, 2 ♀, 5 j ♀ (NCSM C-1818), 25 Jul 1984, RWV, ALB, JEC. FRENCH BROAD RIVER BASIN. *Haywood Co.*—(2) bog near small stream (trib Cold Springs Crk, Pigeon R dr), in rhododendron thicket in steep ravine along FSR 148, Pisgah National Forest, 3.6 rd mi (5.8 rd km) SW jct SR 1334; 1 ♂ I, 2 ♂ II, 4 j ♀ (NCSM C-2192), 23 Sep 1984, ALB, JEC. YADKIN-PEE DEE RIVER BASIN. *Surry Co.*—(3) Horne Crk Off SR 2072, ca. 8.3 air mi (13.3 air km) S town Pilot Mountain; 1 ♂ II (NCSM C-95), 20 Jul 1976, R. M. Shelley, ALB; (4) open bog Schuyler pasture, ca. 0.6 mi (1.0 km) N Low Gap, between E side NC 89 and Gulley Crk (Fisher R dr); 1 ♀, 19 Aug 1994, A. B. Somers. *Wilkes Co.*—(5) Stone Mountain State Park; 1 ♂ I (NCSM C-1106), 16 Jul 1975, D. S. Lee, P. Hertl; (6) Hunting Crk at SR 2428, 0.3 rd mi (0.5 rd km) S NC 115, ca. 9 air mi (14.4 air km) SE Wilkesboro; 1 ♀ (NCSM C-1234), 15 Jul 1976, F. D. Scott, M. E. Filka.

At the Watauga County site the *C. dubius*, cobalt blue in color, were dug from burrows in a mucky seep near the creek. One of the females (NCSM C-1813) had young attached to its pleopods. Thirteen specimens of *C. asperimanus* also were collected at this site, but occupied a different habitat than the *C. dubius* (see the *C. asperimanus* account). At the Haywood County site the *C. dubius*, this time of a brick red color morph, also were dug from burrows in a boggy area, about 3 to 4 m from a small stream. The form I male, one of the form II males, and two of the juvenile females showed considerable exoskeleton decalcification, and the other form II male was soft. In the stream near this bog, eight *C. b. bartonii* were found under rocks or dug from the stream substrate. The female from site (4) in Surry County was found walking in wet grass at about 1900 hours under rainy conditions.

Cambarus (Jugicambarus) nodosus Bouchard and Hobbs

Only two specimens of this burrowing crayfish, females from two separate localities in Cherokee County, have been reported from North Carolina (Bouchard and Hobbs 1976:13). We collected 45 specimens of this species from two additional localities in the Hiwassee River

basin: *Cherokee Co.*—(1) seepage area on slope above SR 1322 and Shuler Crk, 0.1 rd mi (0.2 rd km) E of Tennessee state line, ca. 4.3 air mi (6.9 air km) WSW Violet; 4 ♂ II, 12 j ♂, 2 ♀, 8 j ♀, 1 j unsexed (NCSM C-1786), 1 ♂ I, 1 ♀ (NCSM C-1787), 21 Jul 1984; (2) seeps and shallow intermittent water on hillside above SR 1323 and trib Shuler Crk, 2.8 rd mi (4.5 rd km) W jct SR 1324, ca. 3.3 air mi (5.3 air km) WSW Violet; 1 ♂ I, 4 ♂ II, 5 j ♂, 3 ♀, 3 j ♀ (NCSM C-1788), 21 Jul 1984.

All specimens were dug or scraped from shallow burrows in dark muck. Some of the burrows were submerged in seepage water, and some specimens were found under rocks in these areas. No other crayfishes were found with *C. nodosus*.

In North Carolina, *C. nodosus* is limited to the Hiwassee River basin, where it appears to be the ecological equivalent of *C. asperimanus*. The two species have never been reported from the same localities or even the same river basins anywhere, and *C. asperimanus*, although common and widespread in other montane (and western Piedmont) river systems, seems to be absent from the Hiwassee River and its tributaries.

Cambarus (Tubericambarus) acanthura Hobbs

Although known from two localities in Fannin County, Georgia (Hobbs 1981:219-220), this crayfish has never been reported from North Carolina. Three localities in the Hiwassee River basin of North Carolina are now known: *Cherokee Co.*—(1) floodplain pond and ditches along Nottely R off end SR 1404, ca. 1.0 mi (1.6 km) N US 64 and 5.8 air mi (8.0 air km) SW Murphy; 1 ♂ I, 2 j ♀, 1 carapace (NCSM C-529), 24 Nov 1978, DLS ALB, 5 j ♂, 2 j ♀ (NCSM C-2291), 24 Apr 1985, JB, ALB; (2) floodplain Nottely R at US 64 Bridge, 0.8 mi (1.3 km) E Ranger; 5 j ♂, 3 j ♀ (NCSM C-496), 1 ♂ II (NCSM C-497), 2 j ♂ (NCSM C-498), 1 ♂ I (NCSM C-499), 17 Dec 1976, FDS, ALB; (3) small creek (trib Nottely R) in rhododendron thicket off SR 1423, ca. 0.5 mi (0.8 km) N US 64, 5.0 air mi (8.0 air km) SW Murphy; 1 j ♀ (NCSM C-1790), 22 Jul 1984, ALB, JEC.

At locality (3), the only other crayfish found in the creek was a male II *Cambarus (Puncticambarus) hiwasseeensis* Hobbs. Specimens C-497 and C-499 were kept alive in the laboratory after their capture in December 1976; the former died on 13 May 1980, and the latter, which was a juvenile when collected, died a form I male on 22 May 1981. The pond at locality (1) had extensive mats of floating

water shield (*Brasenia* sp.) when we visited it on 21–22 July 1984. A trap set there overnight yielded no crayfish.

Cambarus (Puncticambarus) georgiae Hobbs

This crayfish has been reported from only three localities, one in Rabun County, Georgia (the type locality), and two in Macon County, North Carolina, all in the upper Little Tennessee River basin (Hobbs 1981:255). The second North Carolina locality was given as "Sugar Fork River 8 mi NE of Franklin on US Hwy 64 . . . 26 June 1957, E. A. Crawford." In response to a query about this site, Hobbs (in litt.) said it should be emended to Cullasaja River, US 64 at Gneiss, 8 mi (12.8 km) SE of Franklin. According to Powell (1968:130), "The Cherokee work, *Kul-say-gee*, means 'sugar' or 'sweet,'" and at least one part of the river apparently was known in the 19th century as Sugar Town Creek.

We collected 39 *C. georgiae* at three localities in the Cullasaja River watershed: *Macon Co.*—(1) Buck Crk at culvert under US 64-NC 28, 0.2 rd mi (0.3 rd km) S jct SR 1535, ca. 0.6 air mi (1.0 air km) S Gneiss; 1 ♂ I, 2 ♀, 2 j ♀ (NCSM C-2155), 20 Sep 1984; (2) Cullasaja R at bridge, jct SR 1667 & 1653, ca. 1.0 air mi (1.6 air km) SSE airport in Franklin; 1 j ♂ (NCSM C-2161), 20 Sep 1984; (3) Cullasaja R along US 64-NC 28, 0.2 rd mi (0.3 rd km) N jct SR 1678, ca. 0.2 air mi (0.3 air km) S Gneiss; 6 j ♂, 9 j ♀ (NCSM C-2158), 3 ♂ I, 1 ♂ II, 1 j ♂, 5 ♀ (NCSM C-2159), 4 j ♂, 4 j ♀ (NCSM C-2167), 21 Sep 1984; this locality is either the same as, or very close to, the second North Carolina locality provided by Hobbs (1981:255).

At locality (1), a single female *C. asperimanus* and 22 *C. b. bartonii* were also taken. At site (3), we also found 29 *C. b. bartonii*.

On 19 and 20 September 1984, we made collections at three localities in the Cullasaja drainage above Cullasaja Falls, at elevations near or above 900 m (3,000 ft). At the highest of these sites we found only a large number of *C. asperimanus*, and at the others we found only 46 *C. asperimanus* and 51 *C. b. bartonii*. Thus, *C. georgiae* almost certainly is absent from higher elevation, high-gradient streams in the Cullasaja watershed.

We can add a second Georgia locality to the range of the species: *Rabun Co.*—Little Tennessee R at Hwy 246, ca. 0.3 mi (0.5 km) E jct US 441, NNE of Dillard; 3 ♂ I, 1 j ♂ (NCSM C-626), 20 Oct 1979, REA, Jr, J. Perry.

Cambarus (Puncticambarus) parrishi Hobbs

This species, which is endemic to the Hiwassee River basin, previously was known in North Carolina from two collections made in Clay County in 1959 and 1960 (Hobbs 1981:267). On 22 September 1984, we collected 21 specimens at two additional sites: *Clay Co.*—(1) Fires Crk along FSR 340, 2.3 rd mi (3.7 rd km) NE of end SR 1344 (which becomes FSR 340), Nantahala National Forest, ca. 4.3 air mi (6.9 air km) NNW cntr Hayesville; 1 ♂ I, 2 ♀, 1 j ♀ (NCSM C-2174); (2) trib Fires Crk (likely Rockhouse Crk) along FSR 340A, ca. 0.8 rd mi (1.3 rd km) N jct FSR 340 and 2.9 rd mi (4.6 rd km) NE SR 1344, Nantahala National Forest; 1 ♂ I, 1 ♂ II, 3 j ♂, 4 ♀, 1 j ♀ (NCSM C-2175), 2 j ♀, part of adult exuvium (NCSM C-2178), 2 j ♂, 3 j ♀ (NCSM C-2180).

Cambarus parrishi was the only crayfish found at site (1), but at site (2) nine *C. b. bartonii* also were collected. Of the four *C. parrishi* taken at site (1), one of the females exhibited exoskeleton decalcification and the male was very soft. At site (2), two males and one female showed decalcification, two of the females were soft, and part of an adult exuvium was found.

Cambarus (Puncticambarus) reburrus Prins

This species is endemic to headwater streams of the Savannah and French Broad river basins, in Buncombe, Henderson, Jackson, and Transylvania counties in the Blue Ridge province of North Carolina (Cooper and Cooper 1977b:214). There is some confusion, however, about the precise distribution of the species. Its type locality is a "Small tributary to the Horsepasture River from Sapphire (= Fairfield) Lake off U. S. 64, 5.5 miles east of Cashiers, Jackson County, North Carolina. Sapphire Lake is an impoundment from which the tributary . . . flows several hundred yards into the Horsepasture River (upper Savannah River drainage)" (Prins 1968:459). It should be noted that Fairfield Lake, although also on a tributary of the Horsepasture River (Long Branch), is about 1.0 air mi (1.6 air km) northwest of Sapphire Lake.

The type locality was the only known site for the species at the time of its description, but four years later Prins and Hobbs (1972:412) added the French Broad River basin to its range and suggested that the "population described by Prins in the headwaters of the Savannah River is an introduced one." Ross (1971:29-32), however, had earlier discussed evidence for a probable Pleistocene breach of the Blue Ridge by Savannah basin headwaters, and "an obvious encroach-

ment of Toxaway River of the Savannah River system upon the headwaters of the French Broad River of the Tennessee River basin." Ross further commented that "Toxaway Creek has not only breached the Blue Ridge but it has also begun to drain some of the 2900 to 3000-foot surface around Lake Toxaway, which once must have been part of the French Broad basin." Later, Hobbs and Peters (1977:11) provided evidence, based on the distributions of fishes and entocytherid ostracods, that "the possibility of a former connection between parts of the two basins exists." Despite these analyses, however, current evidence indicates that Prins and Hobbs (1972:412) may have been correct in suggesting that *C. reburrus* is not native to the Savannah River basin.

The following additional collections of this species are all from the same locality in the general area of the type locality. *Jackson Co.*—pond in floodplain Horsepasture R along US 64, 1.2 rd mi (1.9 rd km) W jct SR 1119; 1 ♀ with young (NCSM C-890), 1 ovig ♀ (NCSM C-891), 5 Jun 1977, ALB, 3 ♀ with young (NCSM C-253, 258, 259), 1 j ♀, 1 ♂ II (NCSM C-260), 4 ♂ II, 1 ♀ 1 j ♀ (NCSM C-912), 27 Jun 1977, DLS, ALB. Several collections made elsewhere in the Horsepasture watershed yielded only *C. b. bartonii*.

At all localities where *C. reburrus* has been taken, it has proved to be a creature of slack or slow-moving waters of low gradient and generally with considerable organic debris. To our knowledge, it has not been taken in swift, high-gradient streams devoid of detritus. Collections we made in September 1984 in two such headwater streams of the Chatooga River south of Highlands, Macon County, streams that in North Carolina are independent of the more eastern headwaters of the Savannah, produced only *C. asperimanus*. Suitable *C. reburrus* habitat is unlikely in the lower Horsepasture and Toxaway rivers, and in the Thompson River. It almost certainly exists, however, in those parts of the Horsepasture watershed between Sapphire and Fairfield lakes and the northern limits of Cashiers, in the headwaters of the Chatooga River in and around Cashiers, in the floodplain of the Toxaway River around Lake Toxaway above Toxaway Falls, and in the Whitewater watershed above Whitewater Falls. We can find no evidence that *C. reburrus* has been taken from any of these areas, but perhaps more field work will reveal its presence in one or more of them.

Although fairly common and widespread in the upper reaches of the French Broad River basin, *C. reburrus* has yet to be verified any farther downriver in this system than eastcentral Buncombe

County (see Prins and Hobbs 1972:412 for localities near Black Mountain and Swannanoa, and the additional Buncombe County locality listed below). Prins and Hobbs (1972:412) reported the species from "Madison County—3.5 mi. west of Old Fort in Pisgah National Forest on U. S. Hwy. 70, . . . 17 June 1940, J. C. Moore, coll.," and added, "These specimens are somewhat atypical and are thus tentatively assigned to this species." Hobbs (1989:27) included Madison County in the range of the species. The locality in question, however, is in McDowell County and in the headwaters of the Catawba River basin, not the French Broad. Old Fort is over 5 air mi (8 air km) east of the Buncombe County line and the nearest headwater creeks of the Swannanoa River (French Broad). The Madison County line is some 24 air mi (38 air km) west of Old Fort, so Madison County is in error. Hobbs very kindly loaned us the specimens collected over 50 years ago at this site (USNM 131904; 1 j ♂, 3 j ♀). Comparison with *C. reburrus* of similar sizes and sexes showed that the questionable specimens did not belong to this species. Hobbs later pointed out (in litt.) that they may belong to an undescribed *Puncticambarus* that occurs in the Catawba River basin, one of those subsumed under *C. (P.)* sp. C.

Further doubt is cast on the occurrence of *C. reburrus* in lower parts of the French Broad basin by collections we made in July and September 1984. We collected over 300 specimens at 11 sites of various kinds in the Pisgah National Forest in Madison County, and 78 specimens at 4 sites in the Pigeon River drainage in Haywood County, but found no *C. reburrus*. Our current knowledge, then, indicates that this species is absent from the Pigeon (and probably Nolichucky) hydrologic units of the French Broad, and from the main French Broad and its tributaries northwest of the Asheville area.

Hobbs and Peters (1977:36) reported the ostracod, *Dactylocythere megadactylus* Hart and Hart, an ectocommensal of several crayfish species, from 37 localities in North Carolina, "in which it is confined to the Piedmont Plateau." They inadvertently listed *C. reburrus* among the ostracod's hosts, but their distribution map for *D. megadactylus* (Hobbs and Peters 1977:71) showed no localities within the range of this Blue Ridge crayfish.

So many additional collections of *C. reburrus* have been made from Henderson County, particularly from the French Broad and Mills rivers, that we see no reason to list them. The following localities, however, are of sufficient interest to be specified: *Buncombe Co.*—(1) Swannanoa R at SR 2416, 0.1 rd mi (0.2 rd km) S jct SR 2002, ca. 1.5 air mi (2.4 air km) NW Wilson; numbers and sexes

not available (NCSM C-2194), 25 Sep 1984, ALB, JEC. *Transylvania Co.*—(2) French Broad R at River Mile (RM) 195.8 along Wilson Rd at head Elm Bend; no other data available, M. Ford; (3) French Broad R at mouth Williamston Crk (RM 192.8) at US 276; 1 ♀ (NCSM C-1686), 23 Jun 1977, MF; (4) West Fk French Broad R near jct SR 1309 & 1312, ca. 4.2 air mi (6.7 air km) NW Rosman; 1 ♀ (NCSM C-2221), 18 Oct 1984, V. Schneider; (5) Davidson R at US 276, 0.2 rd mi (0.3 rd km) SE of FSR to Pisgah Forest National Fish Hatchery, ca. 4.3 air mi (6.9 air km) NNW cntr Brevard; 1 ♀, 13 Aug 1993, J. Weems.

Orconectes (Crockerinus) erichsonianus (Faxon)

Hobbs (1981:263) listed this species and *C. latimanus* as associates of *C. hiwasseeensis* at a locality in the Hiwassee River system of North Carolina. This is the only published record for *O. erichsonianus* in North Carolina. Hobbs (in litt.) said, "the locality is 1.6 miles west of the junction of U. S. Hwy. 64 on State Route 60, Cherokee County—Nottely River, collected on June 12, 1960, by K. W. Simonds . . ." He added, "the whereabouts of the specimens is a puzzle. They were never catalogued and perhaps are still shelved with the uncatalogued material here [at the U. S. National Museum of Natural History]."

On 21 July 1984, we collected 47 crayfish at a site that must have been the same as, or very close to, the one in question — the Nottely River at NC 60, 2 air mi (3.2 air km) SSW of Ranger. This collection contained only *C. b. bartonii*, *C. hiwasseeensis*, and an unidentified *Cambarus*. Collections that we made on several occasions elsewhere in the Hiwassee River basin in Cherokee and Clay counties also failed to yield any *Orconectes*, and the species is not known from this system in Georgia (Hobbs 1981:21, 287). Hobbs later (1989:35, 84, 89) did not include North Carolina in the general range of *O. erichsonianus*, and we are convinced that the species does not occur here. It could have been extirpated from the State, but its historic range just west of North Carolina is limited to the Appalachian Plateau and the Ridge and Valley physiographic provinces, no elements of which are found in North Carolina.

Orconectes (Crockerinus) virginienensis Hobbs

This is one of only two species of *Orconectes* known to occur on the Atlantic versant in North Carolina, where it reaches the southern limits of its range. It is also the only member of subgenus *Crockerinus*

in the State. Its type locality is a tributary of the Nottoway River, which is a major trunk of the Meherrin River, in southeastern Virginia (Hobbs 1951:124–125). The Meherrin River joins the Chowan River at the Gates County, North Carolina, line. *Orconectes virginiensis* originally was known in the Chowan basin of North Carolina from five specimens collected at a single locality in Hertford County: Cutawhiskie Creek (Swamp), a tributary of Potecasi Creek, 1 air mi (1.6 air km) southwest of Menola (Cooper and Cooper 1977c: 215). The collection, made on 13 August 1974 by Chris Ellis, consisted of a form I and two form II males (NCSM C–33), and two females (NCSM C–31, 32). A sixth Chowan basin specimen, an adult female, was collected on 24 July 1985 from a submerged log in the Meherrin River at CR 1175 (Parkers Ferry), downstream from the confluence of Potecasi Creek, about 3.2 air mi (5.1 air km) north-northwest of the center of Winton, Hertford County, by David R. Lenat.

Although Hobbs (1989:38) gave the general range of *O. virginiensis* as “Chowan drainage system in North Carolina and Virginia,” Cooper and Cooper (1977c:215) had reported it earlier from the lower Roanoke River basin in Martin County. A form I male (USNM 116979) was collected in Ready Branch, a tributary of Sweetwater Creek, 4.5 air mi (7.2 air km) south of Williamston, on 28 March 1949 by E. C. Raney. This species is now known from the following additional localities in the Roanoke River basin: *Bertie Co.*—(1) Roanoke R at NC 45/308 at Washington Co line, 5.6 air mi (9.0 air km) ENE cntr Sans Souci; 1 ♀, 2 j ♀, 6 Jul 1986, DRL. *Halifax Co.*—(2) Roanoke R at NC 258 at Northampton Co line, 2.9 air mi (4.6 air km) E cntr Spring Hill; 1 j ♂, 9 Jul 1987, DRL. *Martin Co.*—(3) Ready Br at US 17 bridge, ca. 5.5 air mi (8.8 air km) S Williamston; 1 j ♀ (NCSM C–363), 17 Jun 1980, JP.

The adult female collected at the Bertie County site was found in a submerged log. About this locality, which is not far west of Batchelor Bay, a brackish estuary of Albemarle Sound, Lenat (in litt.) said that the water there was about 200 m wide, slow-moving, and “may be slightly brackish.” He added, “The shore areas have abundant growths of water lily, with many pieces of dead wood on the bottom. Prolific algal growths suggested some enrichment this year. The fauna is primarily freshwater, but also contains some estuarine taxa.” At the Martin County site, a form I male and two female *P. a. acutus* were collected with the *O. virginiensis*.

Occurrence of this species in both the Chowan and lower Roanoke basins is not surprising, since during the Pleistocene the Chowan “would have been a tributary of the Greater Roanoke

River" (Lachner and Jenkins 1971:62). Little has been reported on the distribution and natural history of this species, especially in North Carolina, and it remains one of the State's least known and ostensibly rarest crayfishes.

Orconectes (Procericambarus) spinosus (Bundy)

There are no published localities for the occurrence of any member of subgenus *Procericambarus*, and specifically for *O. (P.) spinosus*, in North Carolina. Hobbs (1981:297) indicated its general range as "Streams in the Coosa and Tennessee river basins in Alabama, Georgia, North Carolina, Tennessee, and Virginia," but later (Hobbs 1989:50, 85, 89) did not include North Carolina within the range of the species. Prior references to *Cambarus* (= *Orconectes*) *spinosus* in the Tar River (Faxon 1890:632; Harris 1903: 130, 142; Ortmann 1905:115, 1931:87, 88), all apparently based on specimens reported by Bundy (1877) from Rocky Mount, refer to the undescribed *Orconectes* sp. A.

North Carolina specimens assigned to *O. spinosus* have been collected at the following localities in the Cheoah River watershed of the Little Tennessee River basin: *Graham Co.*—(1) Tulula (Talula, Talulah) Crk at SR 1211, ca. 0.3 air mi (0.5 air km) E Robbinsville; 1 ♂ II, 1 ♀ (NCSM C-252), 25 Nov 1978, DLS, ALB; (2) Cheoah R just upstream from sewage treatment plant outfall Robbinsville; 5 ♂ II, 3 ♀ (NCSM C-389), 8 Oct 1980, J. H. Davies; (3) Tulula Crk at NC 143, 0.3 air mi (0.5 air km) E cnt Robbinsville; 2 ♂ I, 2 ♂ II, 4 ♀ (NCSM C-1213), 23 Oct 1982, RWV, ALB, D. Sever, 5 ovig ♀ (NCSM C-2302), 2 ♂ I, 1 ♂ II, 19 j ♂, 9 j ♀ (NCSM C-2303), 25 Apr 1985, ALB; (4) Tulula Crk at SR 1138, just N Robbinsville; 7 ♂ I, 1 ♂ II, 5 j ♂, 3 j ♀ (NCSM C-2306), 2 ovig ♀ (NCSM C-2312), 2 ovig ♀ (NCSM C-2313), 4 ♂ I (NCSM C-2352), 26 Apr 1985, ALB.

At locality (2), three of the form II males showed considerable exoskeleton decalcification, and one of them and another form II male and one female were soft. The specimens taken at locality (3) were found under rocks in the creek, and the species appeared to be more abundant than the only other crayfish found there, *C. b. bartonii*. The two species also occurred together at locality (4).

Orconectes (Procericambarus) sp. B

A large species of *Orconectes*, previously considered to be introduced *Orconectes juvenilis* (Hagen) [= *Orconectes (Proceri-*

cambarus) rusticus (Girard)] by Hobbs and Walton (1966) and Hobbs et al. (1967), occurs in the New-Kanawha basin of Virginia (Hobbs, in litt.). This animal also has been taken in New River headwaters at the following North Carolina localities: *Alleghany Co.*—(1) small stream entering New R just E US 21-221, ca. 0.2 air mi (0.3 air km) S Virginia state line, 3.0 air mi (4.8 air km) NNE jct US 21 & 221 at Twin Oaks; 1 ovig ♀ (NCSM C-284), 20 May 1978, REA, Jr, JEC. *Ashe Co.*—(2) South Fk New R at SR 1602, ca. 0.6 air mi (1.0 air km) SE jct US 221, 2.6 air mi (4.2 air km) ENE town Nathans Creek & 7.8 air mi (12.4 air km) NE cntr Jefferson; 3 ♂ II, 2 j ♂, 4 ♀ (NCSM C-257), 20 Jul 1978, DSL; (3) South Fk New R at E side NC 88 bridge and along SR 1588, ca. 0.5 rd mi (0.8 rd km) NE Orion & 4.8 air mi (7.6 air km) E West Jefferson; 2 ♂ I, 1 ♂ II (NCSM C-276), 1 ovig ♀ (NCSM C-277), 1 ♂ II (NCSM C-256), 21 May 1978, REA, Jr, JEC; (4) South Fk New R along CR 1566, 0.3 rd mi (0.5 rd km) S jct SR 1567; 2 ovig ♀ (NCSM C-803, 804), 4 ♂ II (NCSM C-805), 20 May 1978, REA, Jr, JEC; (5) South Fk New R at NC 221, ca. 1.7 air mi (2.7 air km) WSW Scottsville; 1 j ♂, 2 ♀ (NCSM C-2358), 27 May 1985, F. Winborne, DRL; (6) Buffalo Crk near confluence Little Buffalo Crk, ca. 2.5 mi (4.0 km) W cntr West Jefferson; 1 j ♂ (NCSM C-2355), 30 May 1985, DRL, FW; (7) Dog Crk at SR 1592, 4.0 mi (6.4 km) E Jefferson; 1 j ♀ (NCSM C-508), 6 Aug 1978, J. R. Clamp, M. Dennis.

This species was very common at locality (3), where it occurred in close association with another large crayfish, *Cambarus (Hiaticambarus) chasmodactylus* James. The two often were found under the same cover, usually medium-size to large rocks in cold, fast-moving water, and in the same gravel riffles. Both species also occurred together at locality (2). At locality (4), the *Orconectes* was collected with *C. chasmodactylus* and *C. robustus*.

Procambarus (Ortmannicus) medialis Hobbs

Procambarus (Ortmannicus) pearsei (Creaser)

Procambarus (Ortmannicus) plumimanus Hobbs and Walton

These three species comprise a "disjunct" enclave at the northern periphery of the range of the Planirostris Group of the genus *Procambarus*, a fact that is of considerable importance in understanding the evolutionary history of the group. Hobbs (1975:15) summarized their distributions: "The Neuse River basin appears to mark the southern limit of the range of *P. medialis*, the northern [Northeast] Cape Fear River basin marks the southwestern limit of the range of *P. plumimanus*, and the range of *P. pearsei* encom-

passes most of the coastal plain lying in the Cape Fear River basin (excluding the Northern [Northeast] Cape Fear) southward through the Little Pee Dee River basin." The following records and discussions support this statement, slightly expand and clarify the known ranges of these species, add some information on their natural history, and help explain a distributional anomaly for *P. plumimanus*.

Procambarus medialis

As mentioned by Cooper and Ashton (1985:10), although the type locality of *P. medialis* is in the Tar-Pamlico basin in Halifax County (Hobbs 1975:13), this and one other site near it in the drainage of Deep Creek are the only places within this basin where the species currently is known to occur. All other collection sites are within the Neuse River basin. Eleven specimens were captured in wire minnow traps at three localities in the Neuse basin during the *N. lewisi* study (Braswell and Ashton 1985), and one of them was in the mainstem Neuse River in Lenoir County. Identical traps were employed at over 180 stations in the Tar-Pamlico basin, from its headwaters in Person County to central and southern Beaufort County, but yielded no additional *P. medialis*. One of these stations was in Beech Swamp, less than 5 air mi (8 air km) west of Deep Creek, and another was in the Tar River near its confluence with Deep Creek in Edgecombe County. There are no obvious ecological, edaphic, or physiographic reasons, however, for this apparent severe restriction of the known range of *P. medialis* in the Tar-Pamlico basin. During the *N. lewisi* survey, little collecting was done in roadside ditches or isolated lentic waters, and no digging of burrows was attempted. More thorough sampling of these possibly preferred habitats might reveal a wider distribution pattern for *P. medialis* in this river basin, although it also inhabits larger, flowing waters in the Neuse basin.

The following additional localities are in the Neuse River basin:
Johnston Co.—(1) Black Crk at NC 50, 5.5 air mi (8.8 air km) NNE Benson; 1 ♀ (NCSM C-144), 27 Jan 1979, trap, K. Everett; 1 ♀ (NCSM C-230), 30 Jan 1979, trap, KE; 1 ♀ (NCSM C-140), 10 Feb 1979, trap, KE; (2) Hannah Crk at US 701, 10 air mi (16 air km) E Benson; 4 ♀ (NCSM C-1079), 22 Apr 1979, trap, P. S. Freed, 1 ♂ II, 1 ♀, 1 j ♀ (NCSM C-1097), 23 Apr 1979, trap, PSF; (3) dry roadside ditch, Truck Lane and East Rose St, Smithfield; 1 ♂ I, 1 ♂ II, 1 ♀ (NCSM C-2270), 17 Apr 1985, W. M. Palmer, ALB.
Lenoir Co.—(4) Neuse R at NC 55, 1.1 rd mi (1.8 rd km) E jct SR 1809, 5.2 air mi (8.3 air km) NE Kinston; 1 ♂ II (NCSM C-231), 29 Jan 1979, trap, PSF.

At locality (3), each of the three specimens was found under a separate railroad crosstie along the dry ditch, near entrances to burrows that could be seen to reach water. The ditch normally contains water, but this area was in the midst of a prolonged drought that had been broken only by some rainfall on the previous night. Other ditches had some water. In captivity, the form I male, collected in April, molted and died on 29 September 1985, but remained form I.

Procambarus pearsei

Hobbs (1975:14) mapped 22 unspecified localities for *P. pearsei* in the Cape Fear, Lumber, and Waccamaw basins in Bladen, Brunswick, Columbus, Cumberland, Robeson, and Sampson counties. This same map inadvertently indicated an additional locality for *P. pearsei* in the Neuse River drainage of Johnston County. This should have been for *P. medialis*; the position of the dot corresponds to a locality for this species given by Hobbs (1975:13), “. . . 5.3 miles south of Smithfield on U. S. Highway 706.” The nearest headwater stream of the Cape Fear basin, Mingo Swamp, rises at the extreme western edge of Johnston County, about 2.5 air mi (4.0 air km) SSW of site (1) above. Thus, the range of *P. pearsei* given by Hobbs (1989:70) as “Johnston and Sampson counties, North Carolina, south to” currently requires the deletion of Johnston County.

The following localities add *P. pearsei* to the Cape Fear basin in Bladen County, and extend the known range slightly west in the Lumber River basin into Hoke and Scotland counties. CAPE FEAR RIVER BASIN. *Bladen Co.*—(1) pond along SR 1327, 1.6 rd mi (2.6 rd km) NW jct SR 1325, 5.7 air mi (9.1 air km) W Ammon, in vicinity Little Singletary and Horseshoe (Suggs Mill Pond) lakes; 1 ♂ I, 1 j ♂ (NCSM C-304), 17 Mar 1979, P. S. Ashton, REA, Jr., ALB; (2) Horseshoe Lake, 0.7 rd mi (1.1 rd km) NE SR 1327; 1 ♂ I, 8 j ♂, 1 ♀, 6 j ♀ (NCSM C-1602), 23 Feb 1980, PSA, REA, Jr, NCSM Jr Curators. LUMBER RIVER BASIN. *Hoke Co.*—(3) Antioch Bay off NC 211, 1.7 air mi (2.7 air km) SSE Antioch; 4 ♂ I, 3 ♀, parts of ♀ (NCSM C-2240), 1 Feb 1985, RWL, DLS, DFL; (4) pools in powerline cut Antioch Church Bay, E side NC 211, 0.6 rd mi (1.0 rd km) SSE jct SR 1447, 2 air mi (3.2 air km) SSE Antioch; 1 ♂ II, 2 ♀ (NCSM C-2241), 23 Feb 1985, DLS, RWL, DFL. *Scotland Co.*—(5) borrow pit near jct SR 1400 & 1413, ca. 3.5 air mi (5.6 air km) NW Wagram; 1 ♂ I, 1 j ♂, 2 j ♀ (NCSM C-2011), 8 Oct 1974, MRC, WMP, ALB, JEC.

The remains of a form I male and at least one other *P. pearsei* (NCSM C-1277) were removed from the stomach of a redtailed hawk, *Buteo jamaicensis*, found dead near Hallsboro, Columbus County, on 8 April 1983, and prepared as a museum specimen by Gilbert Grant. Seven females carrying late-instar young (NCSM C-2242-2244, 2246-2249) were found at a site in Robeson County on 23 February 1985 by DLS, RWL, and DFL. A female (NCSM C-1951) was found alive on NC 211, about 3 air mi (4.8 air km) south of Bolton, Columbus County, at night on 24 March 1975.

Procambarus plumimanus

Hobbs and Walton (1958:10-11) provided a locality for *P. plumimanus* in Craven County and two in Duplin County, and Hobbs (1975:14) mapped two localities in Duplin County, three in Craven County, one in Carteret County, and one apparently on the Craven-Carteret line. Hobbs (1989:70) added Jones County to the range of the species, but gave no specifics since this was a general checklist. The following localities add to our knowledge of the distribution of this crayfish. NORTHEAST CAPE FEAR RIVER BASIN. *Pender Co.*—(1) borrow pit "Back Island," Holly Shelter Game Lands, 0.3 mi (0.5 km) N Lodge Rd; 1 ♂ II, 4 j ♂, 1 ♀, 1 j ♀ (NCSM C-870), 4 j ♂, 5 j ♀ (NCSM C-871), 3 Oct 1981, REA, Jr; (2) borrow pit Lodge Rd, Holly Shelter Game Lands, ca. 2 air mi (3.2 air km) NW US 17, 5.8 air mi (9.3 air km) SW Edgecombe; 3 ♂ I, 2 j ♂, 1 ♀ (NCSM C-872), 24 Jul 1981, REA, Jr; (3) dr of Harrisons Crk off NC 210, ca. 1 rd mi (1.6 rd km) N jct SR 1574, 4.2 air mi (6.7 air km) NW Hampstead; 1 ♂ I, 1 j ♂, 2 ♀ (NCSM C-933), 13 Mar 1977, E. Flowers, DLS. NEW (WHITE OAK) RIVER BASIN. *Carteret Co.*—(4) borrow pit along SR 1125, 5.3 mi (8.5 km) NW Newport (vicinity Northwest Prong Newport R); 1 ♀ (NCSM C-1942), 25 Mar 1975, MRC, JEC; (5) slough along Millis Rd (SR 1112 extended), 0.7 mi (1.1 km) W jct SR 1124, 5.5 air mi (8.8 air km) WSW Newport (Jason Br of Southwest Prong Newport R); 2 ♂ I, 1 ♂ II, 1 j ♂, 1 ♀, 1 j ♀ (NCSM C-2097), 25 Mar 1975, MRC, ALB, JEC. *Jones Co.*—(6) drainage ditch along FSR 152 (Black Swamp Rd), ca. 7 mi (11.2 km) ESE Maysville, 1 ♂ I (NCSM C-294), 7 Apr 1979, DSL; (7) slough on Great Lake Rd (SR 1101 extended as FSR 126), ca. 10 air mi (16 air km) SE Maysville (Hunter Crk dr); 2 ♂ I, 1 ♂ II, 1 j ♂, 1 j ♀ (NCSM C-2069), 26 Mar 1975, MRC, JEC. *New Hanover Co.*—(8) cypress pond at Carolina Beach State Park; 1 ♂ I, 1 ♀ (NCSM C-850), 3 May 1980, PSA,

REA, Jr; this locality is on a narrow peninsula between the Cape Fear River and Onslow Bay. *Onslow Co.*—(9) permanent ditch and pools along US 17, 0.4 mi (0.6 km) N jct SR 1103, ca. 3.7 air mi (5.9 air km) S Verona; 1 ♂ I, 1 ♂ II, 4 ♀ (NCSM C-70), 10 Aug 1976, M. M. Browne.

Although the natural range of *P. plumimanus* appears to be limited to the Northeast Cape Fear and New (White Oak) basins, and this species did not appear at any of the *N. lewisi* survey stations sampled in the Neuse basin (Cooper and Ashton 1985:10), two localities for the species within the lower Neuse basin are known. The type locality, "Roadside ditch 2.2 miles southeast of Havelock, Craven County, North Carolina on Hwy. 70" (Hobbs and Walton 1958: 10) apparently lies close to East Prong Slocum Creek and not far from the head of Hancock Creek, both north-flowing streams that drain into the Neuse River on either side of the Cherry Point Naval Reservation. Only swamps separate this area from nearby headwaters of the Newport River not far to the south. The second locality, also in the Neuse basin in Craven County, is a ditch along Catfish Lake Road (SR 1100), 3.0 air mi (4.8 air km) southwest of the town of Croatan, in the drainage of East Prong Brice Creek.

This apparent expansion of the range of *P. plumimanus* into the lower Neuse basin possibly can be explained by the fact that in Carteret, southern and eastern Craven, and southern Jones counties, as in much of the poorly drained outer (tidewater) Coastal Plain, contemporary drainage distinctions have become blurred. The drainage divides, very low to begin with, have been breached by stream channelization, a vast system of man-made drainage canals, and the Intracoastal Waterway. Drainage canals along SR 1100 east and southeast of Catfish Lake provide access from the White Oak River basin to West Prong Brice Creek of the Neuse basin. Farther east, the Harlowe (Clubfoot), Adams Creek, and other canals, link elements of the Neuse River with the Newport and North rivers. Precisely what roles the easternmost of these interbasin waterways might play in crayfish distributions will not become clear until we have an understanding of the tolerance that various species display for the physico-chemical features of their waters. Some crayfishes, notably *P. a. acutus* and *Fallicambarus (Creaserinus) fodiens* (Cottle), and even *C. diogenes*, are widely distributed in tidewater North Carolina. They often occur in close proximity to saline estuaries and tidal creeks, and there is a population of *F. fodiens* across Croatan Sound on Roanoke Island. Interbasin connectors also are present in other coastal river basins (see below).

THE HYDROLOGIC UNITS AND THEIR CRAYFISH FAUNAS

Seventeen major river basins generally are recognized within North Carolina (Heath et al. 1975:152). All of them include smaller hydrologic units, some of which are autonomous drainage systems within the State. All but five of the major river basins lie within the huge drainage of the Atlantic Ocean, and flow generally east and south to empty into broad, saline estuaries and sounds of the ocean. The exceptions are (1) the Hiwassee, Little Tennessee, French Broad, and Watauga rivers, which drain north and west into the Tennessee River, and (2) the New River, which drains north and west via the Kanawha River into the Ohio River. These western North Carolina waters ultimately flow into the Mississippi River drainage of the Gulf of Mexico. In North Carolina, the west-flowing and east-flowing montane headwaters of river systems are separated by the Appalachian (Eastern Continental) Drainage Divide, represented in the State by the Blue Ridge physiographic province.

The Waccamaw River and its tributaries, along with Lake Waccamaw, are recognized as a hydrologically and faunistically distinctive drainage unit by some biologists (see Bailey 1977: 269, 273; Shute et al. 1981:18–22), and are so treated here. Another hydrologic unit, the Northeast Cape Fear River, probably also should be considered an autonomous drainage system, because it does not join the Cape Fear River until it reaches the estuary at Wilmington. In addition, the Northeast Cape Fear is faunistically distinct, apparently lacking over a dozen species of lowland freshwater fishes found in the Coastal Plain portions of the Cape Fear itself (Rohde et al. 1979:114–115; Menhinick 1991). The Northeast Cape Fear also lacks two crayfish species found in the lower Cape Fear, but has one species that is absent from the Cape Fear (see below). Historically as well as faunistically, the Northeast Cape Fear appears to have more in common with the New (White Oak) drainage system than with the Cape Fear. During the Pleistocene, when sea level attained its highest stand (as indicated by the Surry Scarp, which marks the marine terrace formed by the Wicomico Sea), much of the southeastern Coastal Plain of North Carolina was covered by the ocean (Rohde et al. 1979:113, 116). This inundated area included today's New (White Oak) River drainage, most of the Northeast Cape Fear, and part of the lower Cape Fear. The early coastal Cape Fear and Northeast Cape Fear basins were at that time broadly separated, and they are still separate systems today.

TENNESSEE-OHIO-MISSISSIPPI

Hiwassee River—The Hiwassee River system rises in the Blue Ridge of northcentral Georgia, and in Clay and Cherokee counties, North Carolina. It flows generally north and west across the southwest corner of the State and into Tennessee, where it merges with the Tennessee River. Two streams of this system head in the southwest corner of Cherokee County and flow south into the Toccoa River in Georgia, part of the Ocoee River system. The Ocoee then joins the Hiwassee in Tennessee.

Cambarus hiwasseeensis and *C. parrishi* are upper Hiwassee endemics, occurring in both Georgia and North Carolina. The type locality of *C. hiwasseeensis* is a tributary to Peachtree Creek, 0.8 mi (1.3 km) north of Peachtree School on US 64A, Cherokee County, North Carolina (Hobbs 1981:260–261). Other species that occur in the Hiwassee system in North Carolina but have broader ranges are *C. b. bartonii*, *C. nodosus*, and *C. acanthura*. The latter two species are known in North Carolina only from the Hiwassee. Hobbs (1981: 20, 22) reported *C. latimanus* in this system in Georgia, and said (Hobbs 1981:263) that it was found with *C. hiwasseeensis* and *O. erichsonianus* at a locality on the Nottely River in North Carolina. In addition, his range map for *C. latimanus* (Hobbs 1981:115) showed Georgia localities west of Nottely Lake in Union County, and in Fannin County just west of the North Carolina state line. Furthermore, Bouchard (1972:36) recorded the species “downstream in the Ocoee (Tennessee) River drainage to the Little Frog Mountains in Polk County, Tennessee.” This area is in the Hiwassee basin just west (downriver) of North Carolina. Thus, *C. latimanus*, which in North Carolina is a species of the eastern Piedmont Plateau and the Coastal Plain, also may occur in the Hiwassee basin of the Blue Ridge in at least Cherokee County. It did not turn up, however, in our Hiwassee field work, which included the Nottely River. Hobbs and Peters (1977:27) cited a record for *Cambarus (Hiaticambarus) longirostris* Faxon in the Hiwassee basin in Cherokee County, “Valley River at Andrews . . . (Crawford 1961:244),” and Hobbs (1981:171–172) found this species in the headwaters of the Nottely River in Union County, Georgia, which is a considerable distance upriver from North Carolina. The distribution maps in James (1966:12–13), however, showed no localities for this species within the Hiwassee basin in North Carolina. In July and September 1984, we failed to collect this crayfish at any site within the system, including the Valley River near Andrews. Nevertheless, *C. longirostris* could occur in the Hiwassee basin in North Carolina. *Cambarus carolinus* also may occur

there, but specific records are lacking. There is a small, forest-green *Cambarus* in Cherokee County that is as yet unidentified.

Little Tennessee River—The main artery of the Little Tennessee River originates in the Blue Ridge of Rabun County, Georgia. Its tributaries drain most of Macon County, and parts of Swain and Graham counties, North Carolina. Its major eastern tributary, the Tuckasegee River, heads in Jackson County and flows northwest into Fontana Lake. Another eastern tributary, the Cullasaja River, begins in southeastern Macon County and joins the Little Tennessee River south of Franklin. A western tributary, the Cheoah River, heads in southern Graham County and flows northwest through Santeetlah Lake, to merge with the Little Tennessee River at Cheoah Dam near the state line. A second major western tributary, the Nantahala River, rises in western Macon County and along the eastern border of Clay County, and flows primarily north into Fontana Lake. Beyond this lake the Little Tennessee flows west into Tennessee, joining the Tennessee River near Lenoir City.

One crayfish, *C. georgiae*, is endemic to the Little Tennessee, where currently it is known from two sites along the main river in Rabun County, Georgia, and several lower elevation sites in the Cullasaja River watershed of North Carolina. More wide-ranging species of this system are *C. b. bartonii*, *C. longirostris*, and *C. asperimanus*. Specific localities for *C. carolinus* are reported here, and Hobbs and Peters (1977:56) referred to a *C. (J.)* sp. in Jackson County (Tuckasegee watershed), which may turn out to be *C. carolinus* or an undescribed species. *Orconectes spinosus* is herein reported from the Cheoah River watershed of this basin.

French Broad River—The uppermost tributaries of the French Broad River rise on the western slopes of the Blue Ridge in Transylvania, Henderson, and Buncombe counties. Its major western tributary, the Pigeon River, heads in western Haywood County and is an autonomous unit in North Carolina. However, it joins the French Broad near Newport, Cocke County, Tennessee. The main eastern tributaries, the Cane, Nolichucky, and Toe rivers, rise in Avery, Mitchell, and Yancey counties. They, too, form an independent unit that flows northwest and enters Tennessee as the Nolichucky. This river then turns west and merges with the French Broad at the upper end of Douglas Lake. The French Broad River initially flows northeast in North Carolina, then turns northwest and enters Tennessee about 5.5 air mi (8.8 air km) downriver from Hot Springs, Madison County. It joins the Holston River at Knoxville to form the Tennessee River.

The endemic North Carolina crayfish, *C. reburus*, is distributed throughout the upper French Broad, but appears to be absent from the Pigeon (and probably Nolichucky) watersheds, and from the main French Broad system northwest of Asheville. The other species of this river basin are *C. b. bartonii*, *C. longirostris*, *C. asperimanus*, *C. dubius*, *C. robustus* (Hobbs and Peters 1977:30), and *C. sp. C.* The type locality of *C. asperimanus* is Flat Creek, Montreat, Buncombe County (Faxon 1914:391). We collected many specimens of what may be an undescribed *Puncticambarus* in three streams in Madison County, but for now these are assigned to *C. sp. C.* Bouchard (1978:36) reported a specimen of *C. latimanus* from the French Broad in North Carolina, extralimital to any part of the known range of the species, but considered it probably an introduction.

Watauga River—The Watauga River rises in western Watauga County west of Grandfather Mountain and flows north and west into Tennessee. A southwestern tributary, the Elk River, heads in northern Avery County. It is a minor independent subdrainage in North Carolina, but joins the Watauga in Tennessee. The Watauga is impounded just beyond North Carolina's borders,³ but eventually merges with the Holston River of the Tennessee River system.

The crayfish fauna of the Watauga River basin in North Carolina is not well known, but consists of *C. b. bartonii*, *C. longirostris*, *C. asperimanus*, *C. dubius*, and *C. robustus*.

New River—The two major western tributaries of New River—North Fork New River and South Fork New River—head in Ashe and Watauga counties, respectively. They flow northeast and merge at the northern Ashe-Alleghany county line to form the New River just before it enters Virginia. Eastern tributaries, Little River and Brush Creek, rise in central and eastern Alleghany County, and flow northward into Virginia to join the New River. The New River merges with the Kanawha River near Charleston, West Virginia.

Cambarus chasmodactylus and probably *Orconectes* sp. B are endemic to the New-Kanawha system, and in North Carolina they are limited to, and close associates in, fast-flowing tributaries of the New River. Records for these common species in the eastern tributaries in Alleghany County, however, are sparse. The other members of the New River crayfish fauna in North Carolina are *C. b. bartonii*, *C. asperimanus* (Watauga County), *C. dubius*, and *C. robustus*.

ATLANTIC

Savannah River—The Savannah River begins as fast-flowing streams in deep ravines on the eastern slopes of the Blue Ridge in southeastern Macon, southern Jackson, and southwestern

Transylvania counties. In North Carolina, its easternmost tributaries—the Toxaway, Horsepasture, Thompson, and Whitewater rivers—flow south as independent streams, entering Lake Jocassee and the Keowee River system of the Savannah basin not far into South Carolina. West of these rivers, the Chatooga River and several even more western tributaries of that river head in Macon County and flow independently south. The Chatooga River forms part of the upper boundary between Rabun County, Georgia, and Oconee County, South Carolina. The Tallulah River, which rises in the southeastern corner of Clay County on the slopes of Standing Indian Mountain, flows south into Towns and Rabun counties, Georgia, where it joins the Tugaloo River of the upper Savannah system.

The crayfish fauna of the Savannah River basin in North Carolina consists of the endemic *C. reburrus* (currently known in this system only from the floodplain of the Horsepasture River in Jackson County), *C. b. bartonii*, *C. asperimanus*, and *Cambarus* sp. (Hobbs and Peters 1977:38). The type locality of *C. reburrus* is in the Savannah basin (see the preceding account for this species). Little is known of the crayfish fauna of the Tallulah River in North Carolina, but *C. asperimanus* and *C. b. bartonii* undoubtedly occur there.

Broad River—This system rises in the west as headwater streams in southern and eastern Henderson, western Polk, and eastern Buncombe counties, and in the north in southern McDowell and northern Rutherford and Cleveland counties. A western tributary, the North Pacolet River, heads in southern Polk and Henderson counties, and flows independently into the Pacolet River of South Carolina. The Pacolet and Broad rivers merge at the juncture of Cherokee, Union, and Chester counties, South Carolina. Eastern tributaries head in eastern Cleveland and western Lincoln and Gaston counties, flow independently into South Carolina, then soon join the Broad River at the line between Cherokee and York counties. The Broad flows through the eastern foothills and western Piedmont of North Carolina, across South Carolina, and merges with the Saluda River at Columbia to form the Congaree River. The Congaree joins the Wateree River (continuation of the Catawba River), and the Wateree flows into the Santee system via Lake Marion.

The crayfish fauna of the Broad River basin in North Carolina consists of *C. b. bartonii* (the eastern and southern limits of its range here are unclear, but it is known from Cane Creek, McDowell County, and Green River, Henderson County), *C. sp. A* (Hobbs and Peters 1977:52), *C. asperimanus* (in southeastern McDowell and northeastern Cleveland counties), and *C. sp. C* (which is probably

throughout the system). The ubiquitous *P. a. acutus* may turn up in the eastern reaches of the basin, and it is not inconceivable that exhaustive effort could reveal *C. carolinus* along the border with South Carolina. The latter species occurs in the upper Tyger River watershed of the Broad-Congaree basin, in Greenville and Pickens counties, South Carolina (Hobbs and Bouchard 1973:60–61). A juvenile male crayfish (NCSM C-2229) that strongly resembles *Cambarus (Puncticambarus) spicatus* Hobbs was collected in the North Pacolet River of the lower Broad basin in Polk County, but it would be premature to add this species to the North Carolina fauna on the basis of this specimen. The species is known with certainty only from a tributary of the Broad River in Fairfield and Richland counties, South Carolina (Hobbs 1989:27).

Catawba River—This heavily impounded system rises in North Carolina, with its headwaters on the Blue Ridge escarpment in southeastern Avery, Caldwell, McDowell, and Burke counties. The streams flow into and through the Piedmont Plateau. Tributaries that head in southern Mecklenburg and western Union counties flow independently south-southwest into South Carolina, where they join the Catawba River in York County. The Catawba flows south into South Carolina, where it enters the Wateree basin of the Santee drainage.

Cambarus b. bartonii and *C. asperimanus* appear to be limited to the foothills and upper Piedmont sections of the Catawba River basin. The former may occur as far south and east as Catawba County at the Alexander County line (Hobbs and Peters 1977:45–46), unless the population there is revealed to be *C. sp. A*. *Cambarus asperimanus* has been found in streams in Burke, Catawba, and McDowell counties. *Cambarus dubius* has been reported from Avery County in the upper Catawba basin (Hobbs and Peters 1977:24). *Cambarus sp. A* and *C. sp. C* may occur throughout the system, and *C. sp. B* currently is known only from Catawba County. *Cambarus reduncus* is known from Gaston, Mecklenburg, and Union counties. *Procambarus a. acutus* has been collected in Lincoln and Gaston counties. Hobbs and Peters (1977:45) recorded *Cambarus (Hiaticambarus) longulus* from a locality in the Catawba basin in northern Caldwell County, but there is evidence that the specimens from that site either came from a tributary of the nearby Yadkin-Pee Dee River, or belong to what appears to be an undescribed species under investigation by JEC. James (1966:13) did not show *C. longulus* in the Catawba basin, and Hobbs later (1989:20) wrote that it ranges “south to the Yadkin basin in North Carolina”

Yadkin-Pee Dee River—The headwaters of the Yadkin-Pee Dee basin rise in the eastern Blue Ridge of Virginia, in western Surry, Wilkes, and southeastern Watauga counties, North Carolina, and in the western Piedmont in southwestern Stokes and western Forsyth counties, North Carolina. The main trunk of the Yadkin River begins in Watauga County east of Blowing Rock, flows southeast to northcentral Caldwell County, then makes an abrupt turn and flows northeast to the juncture of Surry, Stokes, Yadkin, and Forsyth counties. There it turns south and, at the Stanly-Montgomery county line southeast of Badin Lake, joins the Uwharrie River, a major eastern tributary that rises in northwestern Randolph County. This merger forms the Pee Dee River. A major western tributary, the Rocky River, heads in southern Iredell and northern Mecklenburg counties, flows east, and joins the Pee Dee at the Anson County line below Lake Tillery. Several creeks that drain southcentral Union County flow south directly into the Lynches River, South Carolina, a major western trunk of the Pee Dee River. Southeastern tributaries of the Pee Dee drain southern Anson and Richmond counties, flowing directly into South Carolina to join the Pee Dee River in Chesterfield County. The Pee Dee flows across northern South Carolina and merges with the Little Pee Dee River at the tip of Britton Neck. The Pee Dee then continues into Winyah Bay.

In the uppermost sections of the Yadkin-Pee Dee basin occur *C. asperimanus*, *C. longulus*, and *C. dubius*. The southern limits of their distributions are unknown, but all three appear to be restricted to higher elevations within this basin. Specimens tentatively identified as *C. b. bartonii* have also been collected in the upper reaches of this basin. *Cambarus reduncus* occurs in the Piedmont, and *C. sp. C* apparently occurs throughout. Hobbs and Peters (1977: 18) reported *C. sp. A* from Montgomery County, collected with *C. sp. C* and *P. a. acutus*, inadvertently placing the locality ("creek, 4.6 mi . . . W Mt Gilead on SR 73") in the Catawba River basin. Holt and Weigl (1979:24) described the ectocommensal branchiobdellid, *Xironodrilus bashaviae*, from several creeks in Forsyth County, including "Bashavia" (Barshavia = Bechewa) Creek, with *C. b. bartonii* its host. This crayfish could turn out to be *C. sp. A*. *Procambarus a. acutus* has been collected in Anson, Cabarrus, Davidson, Montgomery, and Union counties. *Fallicambarus fodiens* and *C. diogenes* may occur in that part of the basin draining the southeastern Piedmont and Sandhills.

Lumber River—To the west this Coastal Plain system heads in the Sandhills of southern Moore, eastern Montgomery, and Richmond,

Scotland, and Hoke counties. Some of the streams drain directly into the Little Pee Dee River just across the South Carolina line. Eastern tributaries rise in western Bladen and Columbus counties. The Lumber River flows primarily east and south into South Carolina, where it joins the Little Pee Dee River on the Marion-Horry county line south of Nichols.

The crayfish fauna of the Lumber basin consists of *C. diogenes*, *C. sp. C*, *F. fodiens*, *P. a. acutus*, *Procambarus (Ortmannicus) ancylus* Hobbs, *Procambarus (Ortmannicus) blandingii* (Harlan), and *P. pearsei*. A locality for the latter species, given as "CAPE FEAR BASIN. Bladen County: (2) 3.7 mi (6 km) S Dublin on St Rte 41" (Hobbs and Peters 1977:52), actually is in the Lumber River basin. An unidentified *Procambarus*, currently represented in collections by only juveniles and one female, has been found in the Lumber River basin in Robeson and Scotland counties. When form I males become available, this species may prove to be *Procambarus (Ortmannicus) lepidodactylus* Hobbs, which is known from the system in South Carolina, or an undescribed species of the Pictus Group currently known only from the Waccamaw River basin (see below).

Waccamaw River—The northernmost headwaters of the Waccamaw River drain southcentral Bladen and northern Columbus counties, and its eastern tributaries drain western and northern Brunswick County. Some of the northern tributaries enter Lake Waccamaw, the largest of the natural Carolina Bay lakes, and the Waccamaw River flows from the south shore of the lake. East of the lake there is an extensive system of man-made drainage canals that "connects Honey Island Swamp (Juniper Creek tributary) with Dans Creek of the Cape Fear drainage and Big Creek which drains into Lake Waccamaw, . . ." (Shute et al. 1981:21). South of the lake, the Waccamaw River forms part of the line between western Brunswick and southeastern Columbus counties, then flows southwest into South Carolina and enters Winyah Bay. The Shallotte, Lockwood Folly, and Calabash rivers, which drain most of southern Brunswick County, are here included in this system. The Calabash River flows west into Little River in Horry County, South Carolina, and is connected to the Waccamaw River through the Intracoastal Waterway.

The crayfish fauna of the Waccamaw basin consists of *C. diogenes*, *C. latimanus* (known from two localities in Brunswick County), *F. fodiens*, *P. a. acutus*, *P. ancylus*, *P. blandingii*, and *P. pearsei*. Specimens from this basin previously assigned to *P. lepidodactylus* actually represent a new species being described by

JEC. Current evidence indicates that *C. sp. C*, which occurs in the adjacent Lumber River basin, is absent from the Waccamaw basin.

Cape Fear River—The Cape Fear River, which begins in the Piedmont Plateau and drains the largest watershed in the State, is confined to North Carolina. Its major northern tributary, the Haw River, heads in northwestern Guilford, southern Rockingham, Orange, and Durham counties. A large southern tributary, the Deep River, begins in southwestern Guilford and eastern Randolph counties, flows southeast to northern Moore County, then turns east and north, forming the northwestern boundary of Lee County. The Haw and Deep rivers then merge in eastern Chatham County at the Lee County line, forming the Cape Fear River. A central tributary, the Rocky River, heads in northeastern Randolph County, flows southeast through Chatham County, and joins the Deep River at the Lee County line. A major central tributary in the Coastal Plain, the Black River, drains Sampson County and the western part of Duplin County. Another Coastal Plain tributary, the South River, divides Cumberland and Bladen counties to the west from Sampson and Pender counties to the east. The Black River merges with the South River in southern Sampson County at the Bladen County line, and the South enters the Cape Fear at the line between Pender and Bladen counties. The Cape Fear then empties into the estuary at Wilmington, New Hanover County.

Until recently, the endemic North Carolina crayfish, *C. catagius*, was known only from its type locality, burrows in a lawn at East Whittington Street in the southeastern section of Greensboro, Guilford County (Hobbs and Perkins 1967:145), which is in the Haw River subdrainage. Other colonies of this primary burrower have now been discovered, and efforts are being made to more accurately determine its range (Davis 1992:29). *Cambarus reduncus* is restricted to the Piedmont and Fall Line zone, while *C. latimanus*, *C. diogenes*, and *C. sp. C* are found in both the Piedmont and Coastal Plain. *Procambarus a. acutus* appears to be common throughout the system, even into its headwaters. Faxon's (1914:367) report of "*Cambarus blandingii*" from Reedy Creek, near Greensboro, must have been based on *P. a. acutus*, which D. G. Cooper collected from Lake Reidsville and a small lake south of Reidsville, Rockingham County, in the Haw River subdrainage. *Fallicambarus fodiens* apparently has made inroads into the Piedmont of the Cape Fear basin; Hobbs and Peters (1977:46) recorded it from the Rocky River in Chatham County. *Procambarus ancylus* is known from White and Singletary lakes, Bladen County (Hobbs 1958:167), and has been collected from a borrow pit near Colly Creek (NCSM

C-1949), which has a tributary stream entering it from Singletary Lake. *Procambarus pearsei* is known from as far north in the system as northern Sampson County, and might occur in extreme southwestern Johnston County. Its type locality, a pond and ditch on NC 22 south of Fayetteville, Cumberland County (Creaser 1934:4), is in this river basin. *Procambarus blandingii*, which occurs in the Lumber and Waccamaw basins, appears to be absent from the lower Cape Fear, but this needs investigation.

The northern tributaries of the Northeast Cape Fear River originate in the Coastal Plain in southern Wayne and northeastern Sampson counties. The system drains almost all of Duplin, most of Pender, western Onslow, and northern New Hanover counties. The Northeast Cape Fear generally is considered an eastern trunk of the Cape Fear River, but it flows into saline waters at Wilmington, independent of the Cape Fear. As alluded to in the previous discussion of the Northeast Cape Fear as a hydrologically and faunistically autonomous unit, there are differences in the crayfish faunas of the two systems. Since the Northeast Cape Fear is confined to the Coastal Plain, it is not surprising that it does not harbor *C. catagius* or *C. reduncus*, both Piedmont species. It does have *P. plumimanus*, however, which is absent from the Cape Fear but present in the New (White Oak), and lacks *P. ancylus* and *P. pearsei*, both of which occur in the Cape Fear, Lumber, and Waccamaw. The rest of the crayfish fauna of the Northeast Cape Fear is that of the coastal Cape Fear, i.e., *C. latimanus*, *C. diogenes*, *C. sp. C*, *F. fodiens*, and *P. a. acutus*.

New (White Oak) River—The major hydrologic units of the New (White Oak) drainage basin are the autonomous New, White Oak, Newport, and North rivers and their tributaries. All are small and all empty into saline coastal waters behind barrier islands in Onslow Bay, and Bogue and Back sounds. The New River drains the center of Onslow County, and extreme eastern Pender and New Hanover counties. The White Oak drains eastern Onslow County and forms part of the boundary between southeastern Jones and eastern Onslow counties. Included in the White Oak unit are Catfish and Great lakes of Croatan National Forest, southwestern Craven County. The Newport and New rivers both drain southern Carteret County, and both, like the White Oak, are artificially connected with the lower Neuse River basin to the north (see the *P. plumimanus* account).

The crayfish fauna of the New (White Oak) basin consists of *C. diogenes*, *C. latimanus*, *F. fodiens*, *P. a. acutus*, *P. plumimanus*, and probably *C. sp. C*.

Neuse River—The Neuse is a second major drainage system that heads and debouches in North Carolina (for a brief description see Cooper and Ashton 1985:6–7). It includes Long, Little, and Ellis lakes of Croatan National Forest, Craven County. Ellis Lake has a direct connection with Southwest Prong Slocum Creek.

Cambarus reduncus is confined to the Piedmont Plateau and Fall Line zone of this basin, where the southeasternmost known localities are in central Wake County. *Cambarus latimanus*, *C. diogenes*, *C. sp. C.*, and *P. a. acutus* occur throughout the system. *Procambarus medialis*, *F. fodiens*, and *O. sp. A* are essentially Coastal Plain species, with *F. fodiens* and *O. sp. A* both edging into the Fall Line zone at least as far west as southern Wake County. Two localities for *P. plumimanus*, including the type locality, are known in the lower Neuse basin. The listing by Harris (1903:56) of *C. b. bartonii* in the Neuse was in error, and was probably based on Faxon's (1885:61) erroneous report of the species from Kinston, Lenoir County, which also was repeated by Ortmann (1931:131).

Tar-Pamlico River—Like the Cape Fear and Neuse rivers, the Tar-Pamlico is confined to North Carolina (for a brief description see Cooper and Ashton 1985:6–9). Lake Mattamuskeet, part of this system in Hyde County, connects with the Alligator River of the Pasquotank basin through drainage canals and the Intracoastal Waterway, which also forms a direct connection between the Alligator and Pungo rivers. Drainage canals also connect Pungo Lake of the Tar-Pamlico basin, Washington and Hyde counties, with canals from New (Alligator) Lake in the Pasquotank drainage of Hyde County.

The crayfish fauna of the Tar-Pamlico is the same as that of the Neuse basin, except for the apparent expansion into the latter of *P. plumimanus*. During the Pleistocene, these drainages "would have been conjoined to form the Greater Pamlico River" (Lachner and Jenkins 1971:62). In the Tar-Pamlico, however, *P. medialis* appears to be limited to the immediate area of the type locality, a pool in a roadside ditch, 0.6 mi (1 km) south of Scotland Neck, on US 258, in southeastern Halifax County (Hobbs 1975:13). In the Neuse basin its known range is more extensive, occupying an area from Johnston County downriver to Lenoir and Pitt counties. In addition, the Tar-Pamlico range of *Orconectes sp. A* extends from headwaters in Granville County to eastern Pitt County, whereas in the Neuse, despite intensive sampling, this species has not been found any farther upriver than southern Wake County. The report by Faxon (1914:367) of "*Cambarus blandingii*" from Lake Mattamuskeet was undoubtedly based upon *P. a. acutus*.

Roanoke River—The Roanoke is another heavily impounded river. Its major western tributary, the Dan River, begins in the Blue Ridge in Virginia, and in northeastern Surry, Stokes, and Forsyth counties, North Carolina. The Dan flows essentially east and north, moving in and out of North Carolina in northern Rockingham and Caswell counties, and acquiring tributaries in both. It joins the Roanoke at Buggs Island Reservoir in Virginia. The Roanoke then flows southeast into North Carolina, adding tributaries in northern Granville and Vance counties and feeding into John H. Kerr Reservoir and Lake Gaston. The river flows southeast from Lake Gaston, drains southwestern Northampton, northern Halifax, and most of Bertie and Martin counties, then empties into the western arm of Albemarle Sound at Batchelor Bay.

Cambarus longulus and *C. b. bartonii* occur in the upper Dan River watershed, where *C. longulus* is known from no farther east than Rockingham County, and the eastern limits of the range of *C. b. bartonii* are unknown. *Cambarus* sp. C apparently occurs throughout the system. *Cambarus diogenes* and *F. fodiens* occur in the Coastal Plain, but encroach on the Piedmont Plateau, where the western limits of their ranges are uncertain. *Procambarus a. acutus* is found in all of the Coastal Plain, and as far west in the Piedmont as eastern Caswell County. *Orconectes virginianensis* is known from Bertie, Halifax, and Martin counties.

Chowan River—The Chowan River basin is confined to the northeastern Coastal Plain, rising at the confluence of the Nottoway and Blackwater rivers just south of the Virginia state line. The southeast-flowing Meherrin River heads in Virginia, enters North Carolina to form part of the northern boundary between Northampton and Hertford counties, then turns east across Hertford County to join the Chowan at the Gates County line. The system drains northern and eastern Northampton, Hertford, and most of southern and western Gates, western Chowan, and northeastern Bertie counties, then empties into the western arm of Albemarle Sound.

The crayfishes of the Chowan basin are *C. diogenes*, *F. fodiens*, *P. a. acutus*, *O. virginianensis*, and possibly *C. sp. C*. The listing by Harris (1903:53) of *C. b. bartonii* in the Chowan basin (in Virginia) was in error, and was probably based on Faxon's (1885:61) erroneous report of the species from Southampton and Lunenburg counties, which also was repeated by Ortmann (1931:131)

Pasquotank River—North of Albemarle Sound, the streams that form the northern part of this Coastal Plain system rise in the southeastern tip of Virginia and in eastern Gates County, North Carolina. This part of the basin includes the Pasquotank River that

drains northeastern Gates, northern Pasquotank, and the northern half of Camden counties; the Perquimans River of Perquimans County; the Little River that rises in the Dismal Swamp in central Pasquotank County and forms part of the lower Pasquotank-Perquimans county line; the North River that rises in the Dismal Swamp in Currituck and Camden counties; the Northwest River, which begins in Norfolk County, Virginia, and flows southeast into Tull Bay, Currituck County; and the North Landing River, which begins in Princess Anne County, Virginia, flows south into Currituck Sound, and connects with the lower James River of Virginia via the Intracoastal Waterway. All these rivers except the Northwest and North Landing flow into Albemarle Sound.

South of Albemarle Sound the Pasquotank system includes the north-flowing Alligator River, which drains parts of northern Hyde, much of Tyrrell, and most of Dare counties; the Scuppernong River that drains eastern Washington and northwestern Tyrrell counties; and Phelps and New (Alligator) lakes. Both an immense system of man-made drainage canals in the Dismal Swamp west of Phelps and Pungo lakes, and the Intracoastal Waterway, link parts of the Pasquotank basin with the Pungo River, Lake Mattamuskeet, and other parts of the Tar-Pamlico basin in Beaufort and Hyde counties.

The crayfish fauna of the Pasquotank basin consists of *C. diogenes*, *F. fodiens*, and *P. a. acutus*. *Fallicambarus fodiens* has been found across Croatan Sound, near Manteo on Roanoke Island, Dare County.

CRAYFISH DISTRIBUTIONS BY PHYSIOGRAPHIC PROVINCES

Cambarus is the dominant crayfish genus in North Carolina, with 18 described species (not including *C. "acuminatus"*) and at least three known but undescribed species. Nine of these species are limited to the Blue Ridge, three are limited to the Piedmont Plateau, and two overlap the Piedmont and Coastal Plain (one of these two also may be found in all three provinces). Distributions of the taxa now subsumed under *Cambarus* sp. C, which includes *C. "acuminatus,"* will not be clarified until this complex has been diagnosed. Suffice it to say that they occur in all three physiographic provinces. The sole North Carolina species of *Fallicambarus* is primarily Coastal Plain in distribution, but also has invaded the eastern Piedmont Plateau. One of the two described *Orconectes* in North Carolina occurs only in the Blue Ridge, as does an apparently undescribed member of the genus. The other described *Orconectes* is limited to the northeastern Coastal Plain, and a second undescribed

Table 2. Summary of crayfish distributions in major physiographic provinces of North Carolina. X = present.

Species	Blue Ridge	Piedmont Plateau	Coastal Plain
<i>Cambarus</i>			
(C.) <i>b. bartonii</i>	X	X	
(C.) sp. A	?	X	
(D.) <i>catagius</i>		X	
(D.) <i>latimanus</i>	?	X	X
(D.) <i>reduncus</i>		X	
(D.) sp. B		X	
(H.) <i>chasmodactylus</i>	X		
(H.) <i>longirostris</i>	X		
(H.) <i>longulus</i>	X	X	
(J.) <i>asperimanus</i>	X	X	
(J.) <i>carolinus</i>	X		
(J.) <i>dubius</i>	X	? ¹	
(J.) <i>nodosus</i>	X		
(L.) <i>diogenes</i>		X	X
(P.) <i>georgiae</i>	X		
(P.) <i>hiwasseeensis</i>	X		
(P.) <i>parrishi</i>	X		
(P.) <i>reburus</i>	X		
(P.) <i>robustus</i>	X	?	
(P.) sp. C ²	X	X	X
(T.) <i>acanthura</i>	X		
<i>Fallicambarus</i>			
(C.) <i>fodiens</i>		X	X
<i>Orconectes</i>			
(C.) <i>virginiensis</i>			X
(P.) <i>spinosus</i>	X		
(P.) sp. A		X	X
(P.) sp. B	X		
<i>Procambarus</i>			
(O.) <i>a. acutus</i>		X	X
(O.) <i>ancylus</i>			X
(O.) <i>blandingii</i>			X
(O.) <i>lepidodactylus</i>			?
(O.) <i>medialis</i>			X
(O.) <i>pearsei</i>			X
(O.) <i>plumimanus</i>			X

¹ Known from east of the Blue Ridge in Avery, Surry, and Wilkes counties, but eastern limits of range unknown.

² Includes *C. (P.) acuminatus* (s. l.).

species of the genus is essentially Coastal Plain but occurs also at the eastern edge of the Piedmont Plateau. Genus *Procambarus*, with six, and probably seven, described native species, dominates the Coastal Plain. Six of these species are limited to this province, but the seventh also occurs deeply into the Piedmont. Table 2 is a summary of species distributions by physiographic provinces.

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ADDENDUM

After this paper went to press, V. Schneider and D. R. Lenat collected the first *Cambarus spicatus* adults from North Carolina: Cleveland Co., First Broad R at SR 1530, 6.1 air mi (9.8 air km) WSW cntr Casar; 2 ♂ II, 3 ♀ (NCSM C-2487), 20 Jun 1995.

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